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# Welcome!



**THEY'RE CLEVER**, those phone companies. They advertise the latest handset at a knock-down price, and all you have to do is pay £40 a month for the privilege. And even if £40 sounds a bit much, look at all those thousands of free minutes and gigabytes of data you get into the bargain!

However, all those monthly stipends add up. A brand-new iPhone 6s Plus will cost you nearly a thousand pounds over the course of a two-year contract, and you probably won't even use all those minutes and all that data. What's more, if you don't ring up and renegotiate (usually by threatening to leave) at the end of the contract period, you'll end up paying that amount over the following two years, too.

It's far better to keep the cost down in the first place, and that's where this month's guide comes in. Even flagship phones drop rapidly in price after around 18 months on sale, so you can pick up a top-spec handset from mid-2014 for half price or better. Couple this with a cheap SIM-only contract and you'll save

yourself a fortune compared to what's on display in Carphone Warehouse.

In this month's group test we've pitted older flagship phones against current mid-range champions to help you get premium features for budget prices; we'll even take you through the best contract deals. Head to page 78 to grab yourself a bargain.

There was a statistic thrown around a few years ago that every avatar in the then-massive multiplayer game Second Life had the same carbon footprint as the average Brazilian. We're not convinced how true that is, but there's no doubt that the internet, from social networks and web searches to YouTube videos, uses a great deal of power. On the other hand, digital services can also cut down on the amount of energy we use; it uses a lot less juice to send an email than a letter, for example. In our feature on page 100, we attempt to work out whether, from an environmental point of view, the scales tip in favour of the internet or against it.

**Chris Fynamore, Editor**

chris@computershopper.co.uk

MEET  
THE  
TEAM

## QUESTION OF THE MONTH

Now that YouTube Red subscriptions have arrived, what other free tech services would you happily pay for?



**Chris Fynamore**

“SourceForge. Where else would I find intriguing and just-about-functional open-source software?”



**David Ludlow**

“Google Maps: I'd get horribly lost without it. Not Apple Maps, though. Never Apple Maps.”



**Katharine Byrne**

“If Dropbox dropped its free package, my archive of smartphone camera tests would be completely destroyed.”



**Michael Passingham**

“Steam Workshop game mods. Find out why in my Cities: Skylines review on page 61.”



**Seth Barton**

“Hearthstone. I can't imagine going Warcraft-inspired-virtual-card-game cold turkey.”



**Tom Morgan**

“Reddit. There's just no better place to find animated cat GIFs.”



**Richard Easton**

“Instagram. I just can't do without food envy and perpetual Fear Of Missing Out (FOMO).”

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Convert your colour photos into professional-looking monochrome prints with Silver Projects Premium.



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\* FREE SOFTWARE EDITION ONLY

# Letters


While some people are wondering whether the very latest 4K technology is going to take off, others are still stuck in the slow lane of the information superhighway

## CONTACT

### LETTERS

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#### SEPARATION ANXIETY

 I've always believed it was better practice to keep your OS and programs on a separate hard disk partition to your data, so when I was asked about a Windows 10 upgrade for a friend (from 8.1) I suggested she transfer all her photos to the D partition before the upgrade.

Before we upgraded to Windows 10 the PC crashed and it went off for repair. On its return (still running Windows 8.1) my friend commented on my recommendation and the engineer said there was no point as the partitions were like two drawers in the same cupboard.

So it made me wonder, what do the *Shopper* boffins do?

*Allan Postgate*

This won't protect you from data loss if your hard disk goes bang, but we find the main advantage of a separate partition is that it makes it much easier to install Windows; with all your personal files on a different partition, you can happily wipe the system partition without having to copy everything off the hard disk first.



#### NANNY FOX

 I'm really hacked off with Firefox. I hate its auto-update system, and now have good reason to. I found after a recent update that Roboform and Xmarks, useful programs I've used for years without any problems, are deemed by Firefox to be dangerous because they haven't contacted Firefox for approval.

Firefox doesn't just warn me they might be dangerous; it has the cheek to prevent me using them, and proudly informs me there is no way to work around the problem. As I was about to lose both my passwords and bookmarks I did my research and found a little program that overcomes the block. It is called CheckCompatibility and has made my life easier.

If Firefox had just let me choose whether to use these services there would have been no problem, but to remove them when I have paid for them was incredibly annoying.


*Ian Waters*

That is annoying. You should at least have the option to see if they work, rather than the extensions being disabled

↓ A Nexus that reboots itself may be the victim of a broken update

automatically. We've checked Roboform and Xmarks with the latest version of Firefox (40) and they seem to work fine, as long as you download them from the publishers' websites: [www.roboform.com/download](http://www.roboform.com/download) and [download.xmarks.com/download/firefox](http://download.xmarks.com/download/firefox).

#### PAIN IN THE NEXUS


 My wife has a Google Nexus 10 and I have a Nexus 7. A week ago my Nexus rebooted itself in the middle of a game of Subway Surf and got stuck with the swirling coloured dots for many minutes. Power off and on gave the same result: a boot loop.

So I downloaded the previous version, 5.1.0, flashed that and rebooted. Success! A working Nexus 7. All I had to do was go through the one-time setup and reload my apps. But now my Nexus 7 is telling me it's loaded a new system, 5.1.1, and wants me to install it. Worse yet, my wife's Nexus 10 is saying the same thing. Dare I risk it, I wonder?

*Steve Webb*

This sounds like a broken update. Now you've got it working again, we'd ignore the 5.1.1 update, and maybe check back again in a few months. According to the changelog, 5.1.1 is mainly a bug fix release and, as the saying goes, if it ain't broke, don't break it.

#### STRIKING TWICE

 Once again we have just experienced a thunderstorm that cut off our electricity supply for a few seconds. Now my NAS is



↑ Uninterruptible power supplies can protect your kit against power cuts

rebuilding and checking files. Clearly I should be doing something to safeguard the system, but what?


The few uninterruptible power supply (UPS) devices I've handled have all required input and output cables to be the type used by desktop PCs. The QNAP is hard-wired to a UK three-pin plug. Is there any way around this problem? After all, as the use of such devices is becoming much more common, many of us will be in this situation.

*Anne Wilson*

We haven't looked at UPS devices for a while, but they are certainly useful; they can protect against brownouts, surges and losses of power, such as you experienced.


Some are designed just for IEC cables, but there are three-pin plug models. Have a look at [www.apc.com](http://www.apc.com) for some good examples.

#### DON'T SUFFOLK IN SILENCE

 Mike Rose's comments on broadband speeds ('Green with envy', *Letters*, *Shopper* 334) have a great deal of resonance on our housing estate. I live on an affluent estate on the outskirts of Lowestoft, Suffolk, where the majority of houses range from

# ★ Star letter

## 4K OR NOT 4K?

 The review of BT's 4K player (*Shopper 333*) is interesting but highlights the near-void in 4K content, particularly from the broadcasters. There's a good reason for this: 4K is only one of many technology evolutions that will together bring a whole new level of viewer experience. The other two big developments are with wide colour gamut and high dynamic range (HDR). The snag is there are several competing candidates and they all have to be evaluated to determine the standards we'll be using for the next generation of broadcast TV. I am 70 years old and I have seen only three significant broadcast advances; with 625 lines, Colour and HD. 3D could have been the fourth but has failed to get off the ground for broadcasting use.

4K, or Ultra High Definition (UHD), is all very well, but the resolution increase alone is of very marginal use in a typical UK home. Most viewers will be too far from the display to see any significant gains. Many struggle even now to see the difference between SD and HD! The other advances in the pipeline will together with UHD deliver benefits that all viewers will instantly recognise.

Meantime we have to be patient. By all means buy a '4K Ready' TV set if you want to use it on the current meagre content or

➔ Now you can watch your team lose in glorious Ultra HD



perhaps for video games, but don't necessarily expect it to be able to play the new Broadcast UHD content when the new standards are finally agreed. If you visit a large TV display room you will see an amazing set of horrible pictures that are witness to the mess that is the current marketplace. TV manufacturers are desperate to continue selling through these times of change but it's a bit like car manufacturers trying to sell hydrogen-fuelled vehicles with no supply pumps.

*Perry Mitchell*

One of the things we've noticed over the past few years, as display resolutions have crept ever higher, is that resolution improvements tend to look better in retrospect. For example, a 1,280x800 laptop screen looked fine at the time, but when you go back to this resolution from a 1,920x1,080 display, the smaller resolution looks pretty ropey. We find the same is true going from Full HD to SD TV; the standard-definition picture looks decidedly soft, even on a 32in TV.

We can definitely see the difference in 4K video, particularly when watching football, which requires you to concentrate on tiny figures and a tinier ball; 1080p sport looks significantly less clear after 4K. However, we agree that standards need to settle down, so if you already have a TV you're happy with, there's no harm in waiting until more content is available before taking the 4K plunge.

three-bed to six-bed detacheds, but none of the boxes has been upgraded to fibre optic, which leaves me with a maximum download speed of just 1.5Mbit/s. I have many friends who live on the same estate and they are being driven mad by the fact that their children cannot use their PCs, PS4s or Xboxes for online gaming due to ridiculously slow speeds.


I live 1½ miles as the crow flies from the main exchange, but as there is a major water confluence leading from the sea to the broads in between, I assume the cables have to take what seems like a 20-mile detour to get to our part of town.

We have no Virgin Media cable boxes in our area either, so we're stuck with BT ripping us off for a broadband service that falls well short of the service they should be providing to everyone, wherever they live.

*Barry Mansfield*

You don't have to be in the middle of nowhere to get rubbish broadband; even the suburbs of a major town can be affected. According to [www.betterbroadbandsuffolk.co.uk](http://www.betterbroadbandsuffolk.co.uk), however, pretty much the whole Lowestoft area is, or soon will be, wired for fibre, so hopefully you won't have too long to wait.

## COUNTRY MATTERS

 Living in the country, you get used to being ignored by service companies such as BT who see richer pickings in larger centres of population elsewhere.

However, I have a suggestion both for the government (which professes to support widely available high-speed broadband) and BT, who are ever boastful of their achievements regarding broadband speeds.

Any BT customer who receives an actual broadband speed below a certain target

(to be set by Ofcom!) should receive the service free of charge. As BT is forever boasting of its technological achievements, it should welcome this proposal.

The target speed should be set at a certain level throughout the UK. The target could be increased annually, rather like the Cost of Living Index. I would be interested in a response from BT and the government to this suggestion. I know what their customers would say!

*Chris Adam*

If not quite up there with water and electricity, broadband is still a near-essential household service. The limits of standard ADSL connections have now been reached (ADSL can be poor even in urban areas), so the challenge now is to get fibre broadband to every house. This is something BT says it is "working on" with its Rural

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Broadband initiative; you can see the status of the areas involved in the rollout at [www.superfast-openreach.co.uk/rural-broadband](http://www.superfast-openreach.co.uk/rural-broadband). BT's fibre broadband checker ([www.superfast-openreach.co.uk/where-and-when](http://www.superfast-openreach.co.uk/where-and-when)) is also now much more sophisticated than it used to be, and will show fibre rollout down to cabinet level.

Many people, especially in rural areas, will still be stuck with slow connections, however, in which case they may need to investigate alternatives, such as those covered in our 'Fibre for all' feature in issue 324.

### WHAT HACKERS KNOW

 Do you ever receive phone calls at home saying "There is a problem with your PC", from someone in a call centre many miles away?

These calls are a menace if the person being called doesn't know much about PCs and how they work. I get one or two such calls every month. I have good PC knowledge, having built over 15 PCs for myself and others. However, I would like to know where they get the information from, if the information comes from Microsoft and, if so, whether this a breach of the Data Protection Act – and are they actually hacking into your PC?

I have a firewall on both my router and PC, and I know they are really just fishing, in a similar way to PPI phone calls. However,


there will be some out there that will take such calls seriously.

*John Wiesen*

You're right: the scammers have a database of phone numbers and they're just seeing who will bite. There's a high probability that the person they ring will have a computer, and a high possibility that the computer will be running Windows.

The information is certainly not coming from Microsoft (we can't remember ever giving Microsoft our phone number) and they will only try to hack into your PC if you let them by continuing the conversation and not slamming down the phone.

### HUMAX ERROR

 I would be very wary of giving any Humax product a 5-star rating after my experience with the HDR1010S.

I bought one from Currys following your review, to take advantage of the new Freetime catch-up service. It replaced my Humax Foxsat HDR. The 1010S fitted into the same space, satellite connections and HDMI lead as the old model, recognised my router, found 200-odd TV stations and got a great picture, but I couldn't coax any sound out of it. I searched the web and emailed Humax support for help, but found nothing. I swapped HDMI leads and switched between the three HDMI inputs on the TV, but no luck. I tried


recorded programmes and broadcast, but still no sound.

Assuming I had a faulty unit, Currys replaced it and I tried again with exactly the same results. This time I even wrote politely, snail-mail, to the sales director asking for support, but have heard nothing. I had no choice but to return it to Currys for a refund and the old unit is back working as before.

There are two Humax support addresses. One page of the main Humax site gives an email address as [uksupport@humax-digital.co.uk](mailto:uksupport@humax-digital.co.uk), but an email to that comes back from [postmaster@humaxdigital.com](mailto:postmaster@humaxdigital.com) with a great deal of Korean text. Another page gives [support@humaxdirect.co.uk](mailto:support@humaxdirect.co.uk). Nothing comes back from there.

As a PC user and builder since Windows 3.11/DOS 6.22, (I still have the floppy disks) I'm used to PCs misbehaving but these are consumer products – we can't swap bits around or download new drivers. If Humax won't support its products, why should we buy them?

*Bob Delamare*

Companies should reply to emails if they want to keep their customers. The [uksupport@humax-digital.co.uk](mailto:uksupport@humax-digital.co.uk) address works for us, so it may be worth having another go. We also find contacting a company via Twitter can work wonders – Humax is on [twitter.com/HumaxUK](https://twitter.com/HumaxUK). 

## WRITE IN AND WIN

Do you wish your computer was faster when booting and loading applications? Thanks to Crucial, you can achieve your dream of a faster PC or laptop with the BX200 SSD. The writer of our Star Letter will be awarded one of these solid-state devices, which can be installed in a desktop PC or a laptop.

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## NEXT MONTH

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# Upwardly mobile

After finally giving up on his ancient BlackBerry, an intrepid **David Robinson** ventures into buying one of those new-fangled smartphones



**DAVID ROBINSON**  
Software and systems developer  
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**IF YOU'RE A** regular reader you'll be familiar with my faith in the saying 'if it ain't broke, don't fix it'. In my experience a lot of life's unnecessary mayhem flows from ignoring this maxim. However, it's not always good to be a stubborn stick-in-the-mud, and sometimes you just have to bend. My mobile phone contract expires soon and, while I've been a dedicated BlackBerry user for 10 years, I think it's time for a change.

My first mobile, a Motorola, measured about 6x3in and was an inch thick. It didn't do email, though. Good job, as the display was about 40x5mm. That was followed by a Nokia which did do email, provided you jumped through a million hoops to set it up. This had a tiny display and one of those phonepad-type keyboards that assigned up to four letters to each key, so typing in even a tiny message took ages and was full of mistakes. You could save keystrokes by using predictive text, but that led to all manner of unintended word problems. It's no fun enquiring about a part of the male anatomy when all you want is a price.

In 2003, a BlackBerry was a godsend. A real, albeit small, keyboard. Connections to

My last-BlackBerry-but-one had a big screen and touchscreen keyboard. In theory, this meant the screen was big enough for web browsing, but in practice the browser was crap and couldn't cope with any pages with 'fancy' coding. Worse, the touchscreen keyboard was slightly out of kilter, so I often wound up typing an 'F' when I wanted a 'G'. I looked in vain for a calibration routine, but never found one. The current model has a real keyboard again (hurray!), but the browser is still rubbish. Skype only runs on some BlackBerries, so if you don't have the right model you're stuck with paying O<sub>2</sub>'s roaming charges when abroad. Also, the camera on my three-year-old BB is crap. I've come to expect phone cameras to take poor pictures, but the latest generation of phones look pretty good, especially when you consider the tiny lenses they use.

## CHANGE OF HEART

When I looked at what the fancy iPhones, Sonys and Samsung Galaxies can do these days, I started to feel left behind. As my O<sub>2</sub> contract was up this month, I felt it was definitely time for a change. The latest BlackBerry Passport and Z series looked better than what I was used to, but I didn't fancy taking the risk of them not measuring up. The question was: what should I buy instead? My son Gary has an upmarket Sony the size of a fridge door. It's connected to the 3 network and he's very pleased with both the phone and the service. Despite my congenital abhorrence of shopping, a visit to a 3 shop in a local shopping centre was arranged.

I ruled out Apple quickly. I've always been uneasy with Apple's 'do it our way or sod off' approach, which goes way back to the early Apple II. It nearly killed the company before Steve Jobs came up with a glorified MP3 player and called it a pod.

There seemed little to choose between the Sony and Samsung products. The 3 salesman offered me lots of fancy models, most of which were almost as big as my Nexus 7 tablet. Not what I was looking for. What did fit the bill was the Samsung Galaxy A3, which received a five-star rating from Katharine Byrne in *Shopper* 331. She did mention that the graphics speed wasn't up to snuff ("Battle animations were occasionally jerky and sometimes took a second to load"), but my reaction to this was CGAM (couldn't give a monkey's). A swift check on Google confirmed I had invented a new acronym in the same idiom as LOL.

## THREE AND EASY

The compact dimensions, build quality and battery life were the big selling points, along with the contract terms. 600 minutes' talktime (won't approach that), 1GB data (won't approach that, either), 3G or 4G where available, 'all you can eat texts', plus 2,000 minutes of free calls to other 3 users, all for £17 a month. As many of my family and friends are with 3 already, the 2,000 inter-network minutes will be useful. An added bonus is that 3 lets you apply your UK contract limits when you're abroad. O<sub>2</sub> had me on a 'special' rate of £1.60 a day just to connect and send email. The only mystery left is how many calories there are in a text message. Yum!

I used the new phone to send some text messages to my grandchildren. One of the messages contained the acronym LOL. Erin, who's 10, replied and ticked me off for using LOL. "You're too old to use LOL," she said. I asked the obvious question: up to what age is it acceptable to use LOL? She replied that, in the opinion of her age group, 18 is just about OK but, by the time you're 25, you're definitely past it and should stop. That's a PITA! ☹

Predictive text led to problems. It's no fun enquiring about a part of the male anatomy when all you want is a price

multiple email servers. And genuine 'pull' message delivery. No connecting and collecting to get at your correspondence; the BB did it all for you. For people like me who used email as their primary means of communication, nothing else came close. I only used it as a phone when out of the office. Texting, Twitter and Facebook were irrelevant, and my O<sub>2</sub> contract meant I got a new model every two or three years.

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# Court in the act

A new EU court ruling could preserve our privacy, force tech companies to change how they store our data and beat cybercriminals. What's not to like, asks **Gordon Holmes**



## GORDON HOLMES

With more than 30 years of experience in law enforcement, our retired cop gives a police officer's perspective on the sticky subject of cybercrime  
[letters@computershopper.co.uk](mailto:letters@computershopper.co.uk)

**I'M AFRAID** I have to report that I have suffered an accident. Nothing that affected my physical person, you understand, but it did affect my smartphone, which in many ways was just as painful. On the way home from a particularly convivial meeting with colleagues, I checked my messages. I took my phone out of my pocket, slipped, juggled it from one hand to the other and it crashed to the pavement.

Despite being encased in a protective cover, the front screen turned a particularly lurid tartan pattern, so rendering it unusable. I offered thanks to the god that had made me take out phone insurance and, once home, set about restoring the phone to its factory settings before sending it off for repair. After all, I didn't want to hand all my passwords and settings to a stranger.

It was as I sat and watched the (now tartan) Android symbol with its wiggly antenna deleting all my phone data that the thought occurred to me: what about all my contacts? I had never deliberately backed up my phone and here I was, watching all my numbers being deleted.

The European Court could force big companies such as Apple, Google, Microsoft and Yahoo! into some major restructuring

I needn't have worried. Eight days later I received my now fully functioning phone and, after booting up and logging in to my Google account, I was asked if I wished to restore the phone exactly as it was eight days previously complete with personalised background picture. Brilliant – all back to normal.

I should have realised that all my data, contacts and some of the personal settings had all been backed up automatically by Google. This leaves me conflicted.

On the one hand, this silent auto backup is a little creepy, but on the other hand I'm very grateful my phone and email contacts had been backed up without me having to lift a finger.

## HEAD IN THE CLOUD

Automatic cloud data storage is now so commonplace that you may have no idea it's happening or, as in my case, you know but don't give it much thought. Some people do think about it, though. Questions are being asked about where personal data is stored, as well as how it may be used or abused by those storing it.

A court battle currently being played out in the European courts strikes at the heart of these concerns and, depending on the result, could have a profound effect on how our data is stored and, more importantly, where it should be stored.

We all know that most everyday data, such as email, social-networking data from Facebook and Twitter, and contact information from Google and Microsoft, are sent to servers in the United States. Even though the majority of the large tech companies operate data storage facilities within Europe, user data is also sent over to the US, and this is a bone of contention for a growing number of privacy campaigners.

The preliminary court hearing of a case brought by Max Schrems, an Austrian citizen, has resulted in the European Court of Justice issuing an opinion that data-sharing rules between Europe and the US are invalid. His battle has its origins in the leaks from former National Security Agency (NSA) employee Edward Snowden, which showed US authorities had undertaken mass surveillance of European and other 'foreign' citizens under the NSA's 'Operation Prism'.

Schrems argued that EU citizens had no protection against US surveillance once

their data had been transferred to US servers, and that details of Operation Prism leaked by Snowden confirmed this. The court agreed and, while the European Court opinion issued isn't final, this could force big companies such as Apple, Google, Microsoft and Yahoo! into some major restructuring.

## CAMPAIGN MOMENT

The tone of this article may lead you to suspect that I am taking a stance alongside the privacy campaigners and, in a way, I am. Any change in data-sharing rules that leads to our privacy being protected by more stringent EU rules, as well as EU data centres being used for EU citizens, would help my former law-enforcement colleagues' cybercrime investigations no end.

It has long been the case that EU law-enforcement efforts to obtain authorised, legal and proportionate evidence from US servers, in the investigation of criminal offences committed in our jurisdiction, has been stymied by tortuous legal prevarication from US-based operators.

This has led to various UK police forces being accused of doing very little to investigate reported cybercrimes. Often, due to the length of time and the prohibitive costs associated with gathering evidence from the US, the investigation is abandoned by prosecuting authorities as being 'not in the public interest'.

Therefore, if the EU courts do give a legal directive that EU citizens' data should be held within the EU, an unexpected bonus would be that law-enforcement agencies may well be able to investigate the cybercrimes reported to them in a much more timely fashion.

But don't hold your breath. I can't see the big boys taking this lying down. The ruling could cost them millions of dollars; in such a context, an individual's privacy doesn't really matter, does it? ☑

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# RANTS & RAVES

We love our technology so much here at *Shopper* that we're quite happy to be replaced by it. We just wish it wouldn't keep waking us up in the mornings...

Mel Croucher

## RAVES



You may think this elegant prose is hand-crafted by a master wordsmith, but you'd be wrong – we're all down the pub

**WE'RE A GREAT** team here at *Computer Shopper*. We've always been at the forefront of new technology. We've always been able to spot trends before the masses latch on. And we've always been ahead of the curve when it comes to testing new concepts then putting them into practice.

The *Shopper* team embraced artificial intelligence and robotics so long ago that all the recent stories about robots replacing humans aren't even news to us: they're ancient history. Less enlightened publications than ours wake up to the fact that robots can do almost any job better, faster, longer and cheaper than us meaty folk. And then they go back to sleep again.

I hate to be the one to break it to them, but most workers those worried journalists come across today have already been replaced by robots. Robots took over way back, it's just that they didn't notice. If you want to check this for yourself, the easiest way to tell if a worker is a robot or a human

is to smile at them and wait for a reaction. The ones who stare back with dead eyes and glazed expressions are the humans. The smiley and bright ones, they're synths.

Robot supremacy applies to any occupation, as a random jobs list from A to Z will demonstrate: actor, butler, cleaner, DJ, exterminator, fireman, greaser, hacker, interpreter, juror, killer, lover, milker, nurse, obstetrician, pilot, quiltmaker, rapper, shit-shoveller, tutor, urologist, vet, writer... writer! Wait a second, I hear you say, that's your job, and you're human. Aren't you?

Well, am I?

To be honest, I have a confession to make. This item is being written automatically by a five-dollar app, while I take my habitual ease at the Android Arms. I'm happy here. The beer is good, the banter is brilliant, and the barmaid is a dead ringer for Amanda Redman, who is the perfect hostess as long as we keep her plugged in and well greased.

I'm not the only team member in here, of course. The *Computer Shopper* editorial staff claimed their corner of the bar in 1993, just after they adapted Amstrad LocoScript Pro to do their jobs for them.

As for the advertising team, they subcontracted to Cortana as soon as Microsoft dumped the voice of Jen Taylor in favour of Ginnie Watson. And we recently welcomed all the Experts, Labs and Reviews staff when they outsourced their roles to refugee robots fleeing Volkswagen.

As we are all such experts in our fields, we do take on a bit of specialist work now and then. After all, we're only human and we'd get bored letting automatons stand in for us all the time. Besides, the extra cash comes in handy. You may have guessed what we do to keep our hands in, and why we specialise in the only job left for smart humans now that robots can do everything else. That's right, folks, our real job is to design and develop new robots. Cheers.

Richard Easton

# RANTS

If there's one thing sure to make you feel grumpy in the morning, it's sleep-tracking technology that wakes you up too early

**I'M CERTAIN THE** fabled 'morning person' is a myth, a pernicious lie disseminated by cereal adverts and Disney films. I find it impossible to believe that anyone can wake up early feeling refreshed, with a spring in their step and a song in their heart. How I feel first thing in the morning is seemingly totally divorced from how much sleep I've managed to cram in. It's more the case that my brain immediately knows that anything prior to 9am is an ungodly hour to be avoided by all civilised people and therefore fights any will to rouse from slumber.

Apparently this is all to do with sleep cycles. During a night's sleep, your body and brain shifts between various stages of REM (rapid eye movement) and non-REM sleep, with an entire cycle lasting approximately 90 minutes. You go through

several sleep cycles each night. Supposedly it's attempting to wake up at the wrong moment that is so disruptive to your sleep pattern, thereby making you a grumpy ogre first thing in the morning.

It was therefore with a great deal of excitement that I decided to start using 'smart alarm clocks' and 'sleep trackers'. These work using the accelerometers in a smartwatch or fitness tracker, or use the sensors in your smartphone if you tuck the device under your pillow, and track your movement throughout the night.

The promise was that they would monitor my sleep and know which point I had hit in the sleep cycle, so the trackers could then wake me up at the least disruptive moment feeling fresh and rejuvenated. I just needed to program the



tracker with my normal alarm time, along with an 'alarm window' period leading up to it, and the app or tracker would then decide when to set the alarm off to drag me from my blissful dreamland.

The reality is that none of the trackers I've used seems to work particularly well. Such are the vagaries of my sleep cycle that my alarm never fails to go off earlier than the time set, and I still wake up exhausted and wanting to destroy the first thing I see (which is usually whatever the alarm sound is emanating from). Thanks to the wonders of sleep-tracking technology, not only do I not feel any better, I've also been robbed of a few extra minutes of sleep. Proof that the quantified self has gone too far and that no-one should have to wake up before the crack of noon, I'm sure you'll agree.

Chris Finnamore

# RAVES

At last, there's something worth getting excited about in the hardware world, and it comes from a most unexpected quarter: Redmond

**IT'S FINALLY HAPPENED.** Microsoft has got its mojo back. The big M may still be loved by IT departments and hardcore spreadsheet heads all over the world, but it's been a while since it has captured the hearts of consumers. OneDrive? Not a patch on Google Drive or Dropbox. Lumia smartphones? Nice, but everyone just bought Apples and Samsungs. Windows 8? The Marmite OS. Windows RT? A disaster.

Then, at a press conference in October, it all changed (see News, page 16). Everyone got excited about Microsoft. A company that seemed doomed to decline was fired up and bouncing everyone along with it.

A big part of this was Microsoft's renewed push into hardware. The original

Surface tablet may have lost Microsoft \$900 million, and the bill for its various Nokia adventures stands above the \$7 billion mark, but even these massive losses didn't cause the company to run away screaming from manufacturing.

Instead, what we at *Shopper* witnessed at the event was an orgy of enthusiasm and innovation. We had a new Lumia smartphone with a special dock that lets you plug in a monitor, keyboard and mouse to turn it into a proper PC, and even make and receive phone calls while fiddling with Excel. Compare that to Apple's big launch for this year, which was, er, a faster iPhone. We saw a super-powerful Surface Pro 4 to take the fight to the Apple iPad Pro and



Google Pixel C but, most excitingly of all, we saw a laptop: the Surface Book.

This is not only Microsoft's first laptop; it's also the least compromised hybrid we've ever seen. While most hybrid laptops are obviously a tablet attached to a keyboard with a flimsy hinge, we couldn't even tell the Surface Book was anything but a beautiful portable PC until Microsoft's spokesperson ripped it in two before our eyes.

It's like an iPad and a MacBook Air all in one, it looks fantastic and we can't wait to get our hands on one. As Apple stagnates and everyone else is preoccupied with simply copying Apple, we're cock-a-hoop to see one company finally injecting a bit of excitement into tech. 📺

# Microsoft's Surface Book reinvents the laptop

**THE STAR OF** Microsoft's Windows 10 Devices conference in October was the Surface Book, a Windows 10 hybrid that marks Microsoft's very first foray into the world of fully fledged convertible laptops.

The new device came as a total surprise to the technology world, and Microsoft's pumped-up Panos Panay unveiled the device with infectious enthusiasm. Dubbed the 'ultimate laptop', the Surface Book is a veritable powerhouse. Like Microsoft's previous Surface devices, it comes in multiple specifications, and you'll be able to choose from one of Intel's new Skylake Core i5 or Core i7 processors and either 8GB or 16GB of RAM. You'll also have the option to add a dedicated Nvidia GeForce GPU with 1GB of GDDR5 RAM, while storage options range from a 128GB SSD right up to a 1TB SSD.

The Surface Book's 13.5in display has a 3,000x2,000 resolution, giving it a huge pixel density of 267ppi. It also has a 3:2 aspect ratio just like its Surface Pro cousins, making it the perfect size for sketching or annotating web pages in Edge or OneNote with the bundled Surface Pen, which now snaps on to the side of the device magnetically for safe-keeping.

It's a pretty impressive specification for such a tiny device, and Microsoft claims it's twice as powerful as Apple's 13in MacBook Pro, saying that "ounce for ounce, it's the fastest 13in laptop ever made". It's a bold claim, but one that promises to give Microsoft the flagship Windows 10 device it deserves, letting users make the most of Windows 10 without compromising on portability or power.

Housed inside a stunning silver magnesium body, the Surface Book is one of the most attractive laptops we've seen. Its most intriguing feature, however, is its dynamic fulcrum hinge, which rolls outward as you open the display and curls inwards when you close it. It also lets you pull the device in half to use as a tablet, turn the screen round for presentations, or fold back on itself to use as a makeshift clipboard. Of

➔ The dynamic fulcrum hinge is super sturdy, but it also means the display won't lie flush to the keyboard when folded



▲ The Surface Book might look like an ordinary laptop, but Microsoft's latest Surface device is actually a very powerful convertible hybrid

course, we've seen plenty of hybrid laptops that come apart and flip round before, but the difference here is the Surface Book's Muscle Wire mechanism.

Developed in-house at Microsoft, Muscle Wire locks the screen in place via a series of stiff and sturdy clips at the base of the display, providing a stronger, more secure connection than traditional levers. Then, with a press of a button, the keyboard sends a signal to unlock the mechanism, allowing you to pull the screen away easily.

This is important, as the Surface Book's dedicated GPU sits underneath the keyboard, along with a portion of its battery cells, which provide up to 12 hours of battery life. If the Surface Book is still using this GPU when you press the detach button, it won't release the Muscle Wire until it's switched over to the tablet's GPU. It's an ingenious design, adding graphics power when you need it, but without the bulk when you don't.

The keyboard is full-sized and fully backlit, too, and has a five-point multitouch glass touchpad. Along the side of the device you'll find two USB



Surface VP Panos Panay's Surface Book reveal was the most exciting moment of Microsoft's press conference

ports, a full-sized SD card slot, a headphone jack and a Mini DisplayPort.

Of course, you'll need some pretty deep pockets before you even contemplate buying a Surface Book, as US prices currently start at \$1,499 (around £970) for the basic Core i5 model, which doesn't include the Nvidia GeForce chip, right up to \$2,699 if you want the Core i7, 16GB of RAM and Nvidia GPU. UK prices have yet to be announced, but expect them to start somewhere around the £1,000 mark. All things considered, though, the

Surface Book is a huge statement of intent from Microsoft, and we simply can't wait to get one in for testing.





# Surface Pro 4 arriving this month

**MICROSOFT ALSO REVEALED** the next iteration of its Surface Pro tablet range at its Windows 10 Devices conference. The Surface Pro 4 will be powered by Intel's 6th Generation Core processors, previously known as Skylake. These are more efficient than previous-generation chips, but Microsoft didn't go for a low-powered, fanless model; instead, it has opted for a hybrid design that still uses a fan, but reduces the thickness of the overall device. As a result, it's 30% faster than the

Surface Pro 3, and up to 50% faster than a MacBook Air, all the while keeping its chassis size to a mere 8.4mm thick. Other internal upgrades include more memory, up to 16GB, and more storage, up to 1TB.

◀ The Surface Pro 4 has a larger 12.3in screen, but its chassis is still the same size as its predecessor



The display has grown to 12.3in diagonal, but the overall product size hasn't increased; instead the screen bezels have been reduced to make room for the extra display pixels. It will have a resolution of 2,736x1,824, a significant step up from the 2,160x1,440 panel on the Surface Pro 3.

Other additions include an 8-megapixel rear camera, support for the Windows Hello facial security system, and a fingerprint scanner.

The Surface Pen has been updated with 1,024 pressure levels, an eraser on the tail, and all-year battery life. There won't be any need for a pen loop on cases and keyboards, either, as the new pen has a magnet in it that attaches to the edge of the Surface itself. The Surface Pen will be available in five colours and include interchangeable pen tips, to differentiate between ballpoint pen, felt tip pen and pencil sketches.

The Type Cover has a 40% larger touchpad and thinner, scissor design switch keys, making it the thinnest laptop-class keyboard around. The keys are all still backlit, of course, and it docks with the tablet using the same mechanism as previous Surface Pro models. In fact, most of the Surface Pro 3 accessories will be compatible with the Surface Pro 4, including Type Covers, power adaptors, Ethernet adaptors and more.

An official Surface Pro docking station will include four USB3 ports, two 4K DisplayPort outputs and Gigabit Ethernet networking. The dock will be compatible with the Surface Pro 3.

The Surface Pro 4 will be available to buy direct from Microsoft from 12th November. Prices start at £749 for the Core m3 model, but quickly start to rise depending on configuration, with the top Core i7 model going for a whopping £1,799.

## Lumia 950 and 950 XL double up as portable PCs

**ANOTHER HIGHLIGHT OF** Microsoft's Windows 10 Devices conference was the official unveiling of the Lumia 950 and Lumia 950 XL, Microsoft's very first smartphones to run Windows 10 Mobile. Launching in November for £450 and £550 SIM-free respectively, both phones will be able to take advantage of Windows 10's Continuum feature, allowing you to turn your smartphone into a portable desktop PC when you connect it to a monitor via Microsoft's new Display Dock.

This small box has three USB ports for accessories such as a mouse and keyboard, as well as HDMI and DisplayPort outputs for a monitor. Once it's connected to the phone, you'll be able to run full native Windows apps on the big screen, including Microsoft Office, Outlook and 1080p videos. You'll still be able to use your phone to send texts or answer calls while it's connected to the monitor, so you won't have to close everything down when you want to reply to a message.

Both phones look stunning, each one housing a 2,560x1,440 OLED display (in 5.2in and 5.7in screen sizes respectively), 20-megapixel camera, 32GB of onboard storage and fast-charging USB Type-C port.

Microsoft has yet to announce pricing for the Display Dock, but it has the potential to completely revolutionise mobile working. We'll bring you our full verdict as soon as we get one in for review.



Connect your Lumia 950 to Microsoft's new Display Dock and it can turn into a portable desktop PC

# THE RESULTS SPEAK FOR THEMSELVES

# Google's Pixel C sets sights on iPad Pro

**GOOGLE'S RANGE OF** Nexus tablets are some of the best big-screen Android devices you can buy today, but so far all of them have been manufactured by the likes of Samsung, HTC and Asus. However, last month the search giant announced the Pixel C, the very first tablet that's been developed entirely in-house by Google.

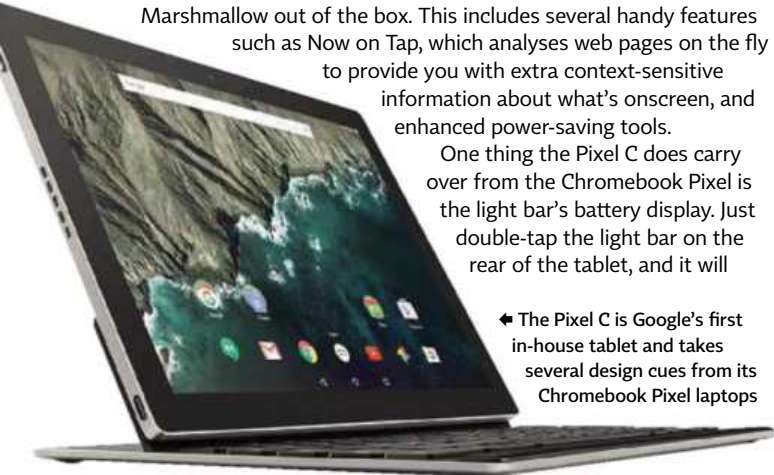
Following in the line of Google's Chromebook Pixel laptops, the Pixel C (which stands for 'convertible') is a truly high-end device, as it has an all-metal chassis and the Chromebook Pixel's unique light bar.

The Pixel will be the first tablet to come with Android 6.0

Marshmallow out of the box. This includes several handy features such as Now on Tap, which analyses web pages on the fly to provide you with extra context-sensitive information about what's onscreen, and enhanced power-saving tools.

One thing the Pixel C does carry over from the Chromebook Pixel is the light bar's battery display. Just double-tap the light bar on the rear of the tablet, and it will

◀ The Pixel C is Google's first in-house tablet and takes several design cues from its Chromebook Pixel laptops



show you how much charge the tablet has left, giving you a handy indication of when you should return it to the mains.

Google wouldn't be drawn on how much battery life you might expect from the Pixel C, but considering its premium specification, we'd be surprised if it outlasts the 12 hours we saw when we tested the Nexus 9. For a start, the Pixel C has a 10.2in 2,560x1,800 resolution screen, giving it a huge pixel density of 308ppi. That's a very high-resolution screen to power, but its quad-core Nvidia Tegra X1 processor and 3GB of RAM will no doubt take their toll as well.

Still, this is an incredible specification for a tablet of this size, and its Maxwell GPU should make mincemeat of games from the Google Play Store. It also has a USB Type-C port for charging and four speakers for enhanced audio and voice recognition for Google Now.

The most interesting thing about the Pixel C is Google's detachable keyboard, which makes it a rival to Apple's iPad Pro. The keyboard attaches to the tablet magnetically, but it can also slide underneath it as a kind of makeshift cover. What's more, it can provide between 100° and 135° of screen tilt, making it immediately more flexible than Apple's fixed Smart Keyboard for the iPad Pro.

The keyboard needs to be charged in order to work, but Google promised that keeping it shut against the screen for a few minutes would be enough to keep it topped up. On average, it should have two months of daily usage on a single charge, so this shouldn't be a problem.

Such a high-end tablet isn't likely to come cheap, with US prices starting at \$499 for the tablet and \$149 for the keyboard when it launches later this year. UK pricing has yet to be confirmed.

## Tesco has 'no plans' for Hudl 3

**IT MAY BE** more than a year old, but Tesco's Hudl 2 is still the budget tablet to beat, having successfully driven off much of its cut-price competition since it came out. However, it seems the Hudl 2 will be the last of its kind, as Tesco confirmed that a Hudl 3 is not on the cards.

A Tesco spokesperson told *Marketing Magazine* it has "no plans" to release a third Hudl tablet. When asked what this meant for the future of Tesco's Hudl range, the spokesperson said there was "nothing planned at the moment".

The Hudl is the best Android tablet you can buy for under £100. While its battery life isn't brilliant, the Hudl 2 has a decent screen and excellent performance, making it great value for money.

It doesn't mean Hudl is gone for good, as "no plans at the moment" could suggest it might still resurface at some point in the future. However, *Marketing Magazine* also learned that several employees who worked on the Hudl and Hudl 2, including the Hudl 2's lead Android engineer Kirwan Lyster, are no longer involved with Tesco. The magazine also reported that a source with knowledge of the matter has confirmed that a Hudl 3 will probably never appear.

It's not just Hudl tablets that Tesco is killing off, though, as it also closed its digital eBook service Blinkbox Books back in January of this year, and sold its Blinkbox on-demand video service and Tesco Mobile network to TalkTalk a few months later.

↓ The Hudl 2 was a revelation when it was first released last year, but we're unlikely to see a new version of the tablet



## TalkTalk suffers yet another data breach

**THE HACK THAT** last month exposed the personal details of four million TalkTalk customers, including their credit card and bank details, was the third major security breach at the company in the past year.

The ISP came clean regarding the full extent of the hack following the launch of a criminal investigation into the attack by the Metropolitan Police Cyber Crime Unit. The company admits it suffered a "sustained external attack" and names, addresses, dates of birth, email addresses, telephone numbers, account numbers and bank details could be at risk.

It appears that the hackers could be about to hold this personal information over the company's head in return for a ransom. Speaking to BBC News, TalkTalk chief executive Dido Harding revealed that the company had received a demand for money, but couldn't as yet vouch for its legitimacy.

"All I can say is that I had personally received a contact from someone purporting – as I say I don't know whether they are or are not – to be the hacker looking for money," she explained.

This marks the third time in a year that TalkTalk has revealed a data breach. In February, names and account numbers were stolen from company computers, and just three months ago the company's mobile sales site was hit by a "sophisticated and coordinated cyberattack". This one appears more serious, however, mainly due to the refusal of TalkTalk to rule out the loss of financial data.

A spokesperson for the company said: "A criminal investigation was launched by the Metropolitan Police Cyber Crime Unit following a significant and sustained cyberattack on our website. We are continuing to work with leading cybercrime specialists and the Metropolitan Police to establish what happened and the extent of any information accessed."

For now, the company advises customers to keep an eye on their accounts, reporting any suspicious activity to their bank or Action Fraud ([www.actionfraud.police.uk](http://www.actionfraud.police.uk)). They should also be aware of the threat of phishing attempts and scam emails purporting to be from TalkTalk which attempt to get users to click on a link or download a file.

# Apple refreshes the iMac with 5K displays

**APPLE HAS REFRESHED** its line of iMacs, adding new high-resolution displays and Intel's Skylake CPUs.

The new 21.5in iMac now has a Retina 4K display (4,096x2,304) model starting at £1,199. The old 1080p 21.5in iMac remains available, starting at £899 (see *Reviews*, page 28).

For the 27in iMac, 5K (5,120x2,880) is now the only display option. When iMacs with this display were introduced, they cost a whopping £1,999. Today, the 27in iMac costs from £1,449. That's quite a bit less than you'll currently pay for the highest-resolution computer screen.

Both iMacs look the same from the outside, but internally Apple has upgraded the processor to Intel Skylake chips. When we tested Skylake we found it was around 13% faster than the equivalent previous-generation Haswell processor. Two Thunderbolt 2 ports come as standard, as does three-stream 802.11ac Wi-Fi (up to 1.3Gbit/s throughput).

Apple has also revamped its range of wireless Magic peripherals. The Magic Trackpad 2 now costs £109 and adds Force Touch, allowing you to press a little harder on the trackpad to take advantage of Apple's pressure-sensitive click features, such as previewing web pages in Safari. There's also the Magic Mouse 2, which costs £65 and has a larger design to make it feel sturdier in the hand.

Finally, there's a new Magic Keyboard, which takes up 13% less desk space than the previous model. It uses a new scissor system on the keys to make for a lower-profile keyboard, and is available for £79.

All the new Magic accessories have integrated rechargeable batteries, which should last around a month on a single charge. Every peripheral is charged via an integrated Lightning port. Plugging any of the new peripherals in via Lightning will also pair them automatically to your computer. All are available now from Apple.

➔ A 5K display now comes as standard on the 27in iMac, and the 21.5in model now has a 4K display



# Nvidia fits desktop GPUs into laptops

**OPTING FOR A** gaming laptop over a desktop PC typically means sacrificing around 20-30% of the total performance, even if the laptop uses the 'same' components as the desktop system. This is because laptop graphics chips are often cut-down versions of the GPUs found on desktop add-in cards, so struggle to deliver the same number of frames or cope with the highest quality settings. Now it seems Nvidia has found a way to add desktop-class silicon into a laptop for uncompromised gaming potential.

The chip in question is the GTX 980, Nvidia's mainstream high-end GPU which is based on the company's incredibly efficient Maxwell architecture. It's no cut-down derivative, either: you get the same number of shader cores, clock speed and 4GB of memory running at 7Gbit/s, the same speed as the desktop card and 2Gbit/s faster than the GTX 980m mobile chip. The GPU will also boost to speeds similar to the desktop chip when temperatures allow it.

The silicon hasn't even had to be redesigned to make it work in a laptop; Nvidia merely binned all but the best performing chips, saving the ones with the best power consumption for laptop use. According to a company rep, the chips are unlikely to have much overclocking headroom, but it will be possible. This is a testament to how efficient Maxwell is, as the 17in and 18in laptops that will use the chip haven't required any real modification in order to cool the GPU.

In terms of real-world performance, 1,920x1,080 resolution gaming on a 17in laptop should be without compromise; expect Grand Theft Auto V to run at 89fps, The Witcher III: Wild Hunt to run at 61fps, and Metal Gear Solid V: The Phantom Pain to run fast enough that the frame cap never drops below 60fps. Three-panel surround gaming will be possible using external displays, and any laptop with a GTX 980 will also meet the minimum specifications for Oculus Rift VR gaming.

Manufacturers Asus, MSI, Gigabyte and Clevo are already on board, with MSI planning to fit two GTX 980s into a single 18in laptop using SLI, and Asus demonstrating a laptop with a water-cooling loop for extreme cooling. Clevo doesn't sell directly in the UK, but supplies its chassis to companies such as Scan, Chillblast and XMG, so there should be plenty of choice once laptops start shipping. Every model will support Nvidia's G-Sync adaptive display technology for stutter-free gaming, too. Just don't expect them to come cheap; based on what we've heard, you shouldn't expect any change from £2,000.

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# Samsung Gear VR will cost just \$99

**OCULUS HAS ANNOUNCED** that the final consumer version of Samsung's Gear VR headset will cost just \$99 when it arrives this month in the US. It will then launch in more than 40 countries in the following months, but we'll have to wait a little longer before we get an exact UK price and release date.

Further good news is that the consumer model of Gear VR will be compatible with all Samsung's current top-end handsets, including the Galaxy S6, S6 Edge, S6 Edge+ and the Galaxy Note 5.

While still powered by the same core technology as Oculus Rift, the consumer Gear VR is a completely different headset to the Innovator Edition that launched earlier this year. It's been designed from the ground up to work with Samsung's 2015 line-up of flagship smartphones, and is 22% lighter than before. The touchpad on the side of the headset has also been completely redesigned to make it easier to use.

The headset will feature all-new games, videos and experiences. Minecraft will be shipping next spring, while Monument Valley

developers UsTwo will be releasing the headset's first exclusive title, Land's End. Alternatively, those who fancy something a little more retro will be able to play more than 20 classic games via Oculus Arcade from the likes of Sega, Warner Bros Midway and Bandai Namco, including Sonic the Hedgehog, Gauntlet, Spy Hunter and Pac-Man.

Oculus Cinema has been renamed Oculus Video, and the company has been working with several Hollywood studios, including 20th Century Fox and Lionsgate, to let users watch over 100 films, including *The Hunger Games: Mockingjay Part 1*, *X-Men* and the *Alien* trilogy, from their front room. Alternatively, you can pop on Netflix VR instead.

Twitch is coming to Gear VR, too, allowing you to watch friends play games via a virtual reality avatar. Other services include Vimeo, Tivo and Hulu, but it's likely that most of these will be exclusive to the US version. One thing you won't miss out on, though, is Facebook's 360° News Feed videos, as these will also be available to view straight from your headset.



▲ The headset itself may only cost \$99, but you'll still need an expensive smartphone to use it

While UK pricing has yet to be confirmed, a \$99 (around £65) headset is certainly a lot cheaper than we were expecting, so it hopefully won't break the bank when it does eventually arrive on UK shores.

## All Freeview-branded kit to be HD from 2016

**IT'S BEEN A** long time coming, but by the end of 2016, the Freeview Trade Mark Licence will no longer appear on SD products. According to Freeview, HD products accounted for 70% of new Freeview TV sales in the UK during 2014, leaving a significant chunk that weren't Full HD.

Guy North, managing director of Freeview, said: "Freeview HD gives consumers the best possible picture quality without a subscription. By moving all Freeview products to HD, we are ensuring that our viewers get the full range of channels available to them on the platform and the best possible quality. The company has been working closely with manufacturers, retailers, government and other industry stakeholders to future-proof the platform."

Freeview's research shows that picture quality ranks highly for importance with television viewers. Richard Lindsay-Davies, CEO of the Digital TV Group (DTG), said: "The industry has given unanimous support, through its collaboration in the DTG, to Freeview's move to ensure all their viewers enjoy the rich experience of high-definition TV with the reliable experience to which they have become accustomed from the world's greatest industry-defined and open digital TV platform."

Televisions above 32in with Freeview built-in will be going Full HD from 1st January 2016 in order to carry the Freeview trademarked brand, with the remaining Freeview equipment, such as set-top boxes, going HD after 31st December 2016. The new Freeview Play service is also expected to launch later this month, which will integrate the terrestrial channels' catch-up on-demand services to allow viewers to watch content from the previous week. This is similar to how Freetime works on Freesat boxes, as well as YouView's on-demand integration.

◆ Freeview HD will be built into all TVs above 32in from the beginning of 2016



## LG unveils dual-display flagship smartphone

**LG HAS UNVEILED** its next flagship smartphone, the V10. Taking several cues from the LG G4, the V10 has a number of additional features to make it a truly premium handset.

The first is its second, always-on display, which runs along the top of the phone above the main 5.7in 2,560x1,440 display and shows the time, date, weather, battery bar and notification icons when the screen is turned off. When the main display is on, the second screen can be used to display music controls, calendar notifications and shortcut icons, allowing you to jump in and out of apps without having to return to the main homescreen.

The V10 will ditch the G4's leather casing for what LG calls 'dura-skin', a kind of soft-touch textured material designed to protect against scratches and enhance the phone's overall durability. It will also have a stainless steel 'dura-guard' frame but, like the G4, it won't be a unibody chassis. Instead, the dura-skin casing can be removed, so you can get to the removable 3,000mAh battery. You'll also find a microSD card slot here, which can take cards up to a massive 2TB in size, and the phone will come with 64GB of onboard storage as standard. It's a fairly hefty device, though, as LG has said it will weigh 192g and measure 159x79x8.6mm.

The V10 has the same hexa-core Qualcomm Snapdragon 808 chip as the G4, 4GB of RAM, and a 16-megapixel rear camera. The V10 also has dual front-facing cameras, one of which has a narrow 80° lens for selfies while the other has a wider 120° lens. Both sensors only have a 5-megapixel resolution, but the V10 can combine these images together to create wider group shots. Like the G4, the V10 gives you full control over shutter speed, white balance, focus and ISO levels, while video mode lets you control the frame rate and switch aspect ratios.

The V10 will be available in Korea later this month, with the US, China and other countries following soon after. There's no word on pricing or an official UK release date yet.



# Toshiba Dynapad challenges Surface Pro 4

**TOSHIBA HAS ANNOUNCED** the Dynapad, a new Windows 10 convertible it hopes will take on Microsoft's Surface Pro 4 when it launches next year. In tablet mode, the device measures 6.9mm thick and weighs 569g, making it the world's thinnest and lightest 12in Windows 10 tablet. However, like the Surface Pro 4 and Lenovo's IdeaPad Miix 700, the Dynapad can transform into a fully functioning laptop with a full-size keyboard that snaps to the bottom of the screen.

Toshiba is also hoping the Dynapad will "reinvent pen and paper", as it's been designed to replicate the size of a common B5 notebook. To help achieve this, it comes with a pressure-sensitive Wacom Active Electro-Static stylus, allowing users to draw directly on the tablet.

The stylus comes with built-in palm rejection, so you can rest the side of your hand on the screen without worrying about making marks on your handwritten notes or digital annotations, and supports both left- and right-handed writing. It's not magnetic, like the Surface Pro 4's Surface Pen, but you can clip it to the side of the tablet when it's not in use, so it shouldn't get lost in your bag when you're on the move.

As well as Microsoft Office, the Dynapad will come with a full suite of Toshiba applications to help collect, organise and share your notes with friends and colleagues. These include TruNote, TruCapture, TruRecorder, TruClip and TruNote Share, so you can take voice recordings or capture images of text, for example, and share them effortlessly via email and PowerPoint across multiple devices.

The display itself will measure 12in across the diagonal and have a 1,920x1,280 resolution. It will also have an anti-reflective coating to make it easier to see, as well as what Toshiba calls a 'double-layer coating' to help reduce the number of fingerprints it picks up. All this will be housed inside a Satin Gold carbon body, which Toshiba says is four times as stiff as a conventional chassis. The keyboard can also be used to protect the screen when you're carrying it around.

Toshiba has yet to announce a price and exact processor specs for the Dynapad, but hopefully it offer a slightly more affordable alternative to Microsoft's expensive Surface Pro 4.



◆ With music, video and original content all united under one banner, YouTube Red could be one of the best-value subscription services yet

## Ad-free YouTube Red service launches in US

**YOUTUBE HAS LAUNCHED** its own ad-free subscription service called YouTube Red. Priced at \$9.99 a month in the US, it marks Google's first step toward taking on rival services such as Netflix and Amazon Instant Video, as users can watch videos on all their devices without adverts, save videos for offline use, and play videos in the background while using other apps or when the screen is off. The service also extends to YouTube's recently launched Gaming app and its new YouTube Music app, and includes a free Google Play Music subscription.

With so many strings to its bow, this makes YouTube Red a bargain, especially compared to other \$10 music services such as Spotify and Apple Music. While there's no UK price confirmed at the time of writing, Google could charge £10 to match Spotify, but we're hoping it costs a more reasonable £7.49, the same as the HD version of Netflix.

Ad-free playback on all videos means subscribers will be able to enjoy all their favourite YouTubers without interruption. The news has caused something of a ruckus among content creators, but Google seems confident that the new funding model won't disrupt current earnings, or jeopardise the future of content creators.

You'll also be able to save any video to your smartphone or tablet to watch offline later. You can also get videos to play in the background, so you can keep listening to a show while you quickly reply to an email.

YouTube is also upping its game with higher-budget Exclusive Red Originals, from the likes of PewDiePie, the Fine Brothers, Rooster Teeth and CollegeHumor. This is a savvy move, elevating its biggest home-grown stars, keeping them on the service, and giving their huge fanbases an immediate reason to upgrade to the new service.

With Amazon rolling its Prime Instant Video service into its other products, and Netflix offering high-quality original content, Google needed a unique way to get users to pay for its video service, and it's managed to do so on several fronts.

YouTube is starting from an incredibly strong position: it already has millions of videos produced by its users; people already know what YouTube offers and there's something for pretty much everyone already uploaded. Busting through ads with a subscription fee is something a lot of people are going to be interested in, as is the ability to watch offline and in the background, but it's the two-in-one deal of videos and music that will really appeal.

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# How software let VW beat emissions tests

Volkswagen's software enabled its cars to reduce emissions when under test conditions. **Curtis Moldrich** reveals how

**IF YOU EVER** need proof that software is seriously powerful and controls everything we do, the Volkswagen scandal is it. VW is in massive trouble after it used software in its cars to cheat on an emissions test, fooling the US Environmental Protection Agency (EPA) into thinking that Volkswagen's cars were cleaner than they really are.

The company has already admitted its part in the scandal, and has recalled just under 500,000 cars in the US, but over 11 million cars worldwide could be affected, including over 2.1 million Audis that use the same emissions-cheating software. Audi says 1.42 million of its cars in Western Europe may be affected, including 577,000 in Germany, as well as just under 13,000 in the US.

VW Group CEO Martin Winterkorn was forced to resign after growing pressure to step down, and his departure was followed by suspensions for the heads of R&D at Porsche, VW and Audi.

Reports also suggested that Winterkorn could face a criminal investigation and charges of fraud, with lawyers claiming that he knowingly used and fabricated emission figures to sell cars.

The company has already set aside €6.5bn (£4.7bn) to cover the potential cost of the crisis, and it could also face fines of \$18 billion and possible legal action in Europe and the US. It's clearly a big deal, so what did it do?

## THE TEST

Diesel fuel contains a lot more energy than regular unleaded fuel, and diesel engines are more efficient. The combined result is that a



Diesel cars are fitted with a particulate filter to reduce emissions

diesel car is able to travel around 30 per cent further on the same amount of fuel than a regular petrol model. As good as that is, the trade-off is that diesel cars emit more nitrogen oxides (NOx), which contribute to smog, and particulate matter, which can be responsible for lung damage. It's for the latter reason that diesel cars carry particulate filters, which collect the bigger particles. As the car heats up, the filter gets hot and burns the larger particles, releasing smaller, less damaging particulates into the air.

While here in the UK we're largely more tolerant of diesel cars, believing the extra fuel economy outweighs the more damaging emissions, it's a different story in the US. In

fact, as part of the country's Clean Air Act, the EPA has very strict NOx emission standards.

To enforce these rules, the EPA takes cars off the assembly line at random, and conducts a number of emissions tests, monitoring for substances such as NOx. Usually carried out when the car is connected to a rolling road – or with one axle moving and the other stationary – the tests take place at constant speeds, with little or no steering movement.

## WHY DID VW CHEAT?

To reduce NOx output, car manufacturers have a couple of options. First, a Lean NOx Trap (LNT) can be used to absorb NOx, but they easily become saturated, which means they have to be regenerated by pumping extra fuel into the engine. This leads to higher fuel consumption and lower performance.

A second option is to use a selective catalytic reduction (SCR) device, which is fitted to the vehicle's exhaust. This uses a catalyst (urea) to convert NOx into nitrogen and water, dramatically reducing harmful emissions. The problem with this system is that the urea has to be replenished regularly, so these devices are generally only fitted to large vehicles.

Both methods reduce performance, so the idea is to find a balance between fuel economy and emissions. In this case, VW couldn't find a way to balance performance with emissions, so it decided to cheat.



VW has been caught cheating in US emissions tests



It's the EPA's job to make sure that cars pass its strict emissions tests

### HOW DID VW CHEAT?

New evidence found by the EPA shows that Volkswagen developed a piece of software (dubbed a 'defeat device') designed to look out for the test conditions and then run the car in its most efficient mode.

"The test cycles are very formal and well established, so priming a vehicle to sense when it is being tested is potentially quite straightforward," Professor Alastair Lewis, an air pollution expert at the University of York told the *Financial Times*. "For example, are only its drive wheels turning, is the acceleration unnaturally smooth, or are the constant speeds too precise for a human driver?"

While other manufacturers have a test

VW's software enabled its cars to detect when a test was being carried out



were used, from reducing the amount of urea used to replenishing the LNT less often.

As well as skirting round rules designed to help the environment, the EPA says the action was unlawful and led consumers to buy a different product from what had been advertised.

### WHAT HAPPENS NOW?

VW has had to recall all of the affected vehicles in the US, removing the 'defeat device' from each of them and retro-fitting

the VW scandal has led to people examining diesel cars in more detail, with latest reports suggesting that they're not as clean as we've been led to believe. Testing funded by the Department for Environment, Food and Rural Affairs (Defra) has shown that diesel cars, on average, emit more than four times the legal limit of NOx gasses.

The controversy has also thrown open wide the debate about how cars are tested: rolling roads and test conditions make it easy for software to detect whether a car is being tested and to adjust its output accordingly. Real-world testing on real roads seems the only sensible solution. ☑

## As soon as the cars were on the road, the software tweaked the environmental protection systems to increase performance

mode that can force traction control systems to ignore the strange behaviour of the car's front and rear axles, this is the first time any car maker has used a test mode to change the fundamental behaviour of its engines.

The result? Every affected Volkswagen was able to pass the EPA emissions test. As soon as the cars went out on to the road, the software tweaked the environmental protection systems to increase performance while producing nitrogen oxide emissions up to 40 times higher than the test conditions. Depending on the car, different techniques

them so that they properly pass the emissions tests. The company faces heavy fines from regulators and may even receive civil lawsuits from customers that will, quite rightly, say that they were duped into buying a car that was promoted as being more environmentally friendly than it actually is.

### WHAT ABOUT THE UK?

Diesel cars are extremely popular in the UK because of their better fuel economy and reasonable road tax, thanks to the lower CO<sub>2</sub> emissions compared to petrol cars. However,

## NOT JUST MOTORS

While cheating benchmarks may be recent revelation in the automotive industry, it's been a common feature in technology – especially smartphones – for some time. In 2014, HTC admitted that its One M8 smartphone was able to detect benchmark software, and run the CPU flat out at the expense of battery life. It isn't alone, either: Samsung's Galaxy S4 and Galaxy Note 3 were able to detect the presence of benchmark software, such as SunSpider, and run flat out when needed.

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# REVIEWS

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## HYBRID LAPTOP

### ACER Aspire Switch 11 V



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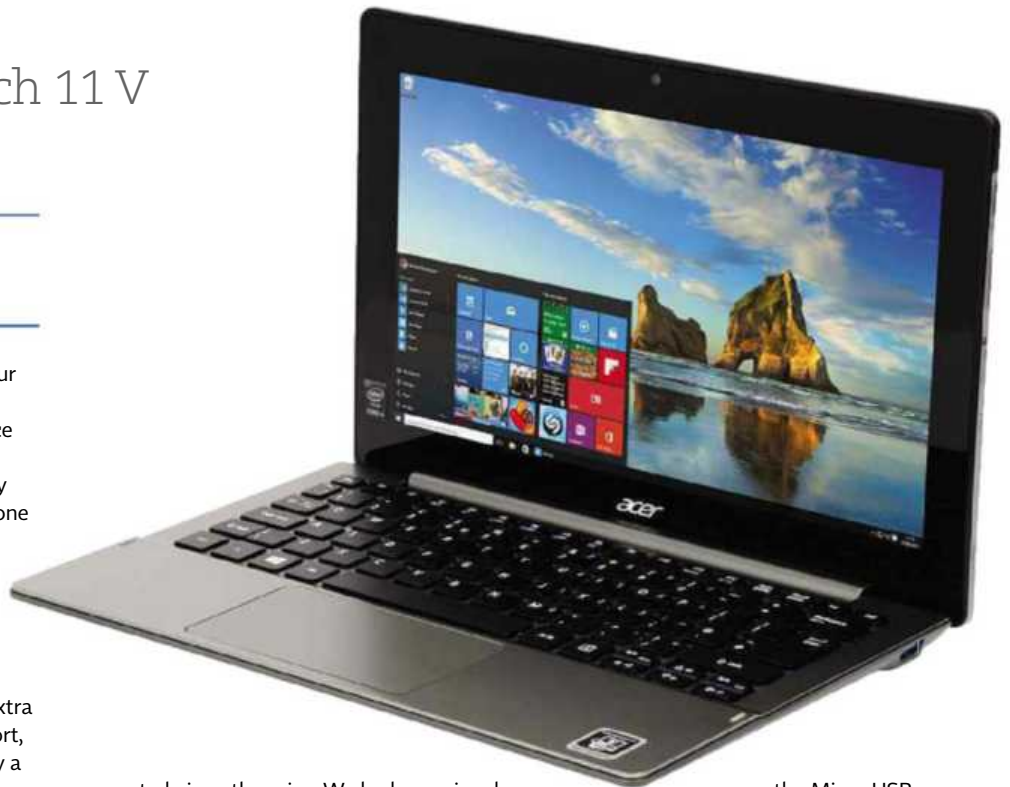
#### VERDICT

So close to being a Surface 3 beater, but battery life is lamentable

**THE MICROSOFT SURFACE 3** is one of our favourite Windows tablets; it has a great screen and sprightly performance, but once you factor in the cost of the optional TypeCover – which we consider a necessity for actually getting anything productive done on a tablet – it stops looking such a good bargain. Acer's Aspire Switch 11 V, on the other hand, looks fantastic value. Spec for spec, the 11in Windows 10 tablet eclipses the base model Surface 3, with a bundled keyboard and faster processor.

That keyboard dock might add some extra weight, but it also adds a full-size USB3 port, which is crucial as the tablet itself has only a Micro USB port. The tablet and keyboard dock securely with magnetic prongs, making it one of Acer's better attempts at a locking system. It's not perfect, though; when folded shut like a laptop, the hinge mechanism is too stiff to open with one hand. At times, we accidentally tore the tablet off the dock, chucking the whole thing across the floor in the process. Adding a quick-release button may have ruined Acer's minimalist approach, but it's the only way to ensure ham-fisted types don't have to keep raising their home insurance premiums. The tablet can also be docked backwards in 'tent' mode, for when you don't need to type and want a hands-free way to prop up the screen.

The sensitive touchpad is great for navigating around Windows when using the tablet in laptop mode, and the keyboard is responsive when typing. The keys are slightly shallow, but no more so than other tablet docks, and each one is sensibly spaced. The keyboard isn't backlit, but that's to be



expected given the price. We had occasional errors using the touchscreen, where a scroll gesture would be interpreted as a zoom, but this was rare enough not to be a major issue.

#### PLASTIC FANTASTIC

The tablet itself looks fantastic considering the price. The frame is made from plastic, but the thin, crosshatched aluminium plating on the rear adds a touch of class. A thin strip of textured plastic running across the top gives you something to grip when holding the tablet in portrait mode. There's also very little in the way of bend or flex. It's a commendable effort, even if it can't match the premium feel of the Surface 3, which is machined from aluminium. Despite the cheaper materials, however, the Switch's tablet weighs 760g – much more than the Surface 3's 622g.

There's a microSD card slot, Micro HDMI video output and the aforementioned Micro USB connector on the left edge of the tablet. There's also a separate charging port, which

means the Micro USB connector is always free, even when the tablet is connected to the mains. Micro USB is useful if you have any USB OTG devices, but you'll still need an adaptor if you want to connect any full-size USB devices when the tablet isn't docked.

At 11.6in, the tablet is slightly too large to use one-handed for any length of time, but once docked it's perfect for watching films in bed or on the sofa. Acer has placed the speakers on the front for clearer audio. They sound loud and crisp, easily surpassing most rear-firing or downward-firing laptop speakers. You won't need to reach for your headphones for anything other than critical listening.

#### FULL MONTY

With Microsoft managing to fit a Full HD panel on the Surface 3 without compromising on price, Acer had no choice but to follow suit, so the 1,920x1,080 screen is an unsurprising yet welcome inclusion. Everything looks sharp, and there's lots of room onscreen for full-size desktop websites. Some people may find icons and text just that little bit too small for comfortable use, but a quick trip into Windows 10's display-scaling options will make everything larger.







p28 | Apple iMac 21.5in (2015)



p36 | Sony Xperia Z5



p46 | Nvidia Shield Android TV



p54 | Samsung 950 Pro



p61 | Cities: Skylines After Dark

Image quality is merely respectable for the price. The screen is exceptionally bright, producing peak whites at 377cd/m<sup>2</sup>, and contrast is good, too, with a 1,000:1 ratio. Colours look fairly punchy, helped by above average viewing angles, but otherwise there's not much to shout about. Colour accuracy is poor, with coverage on the sRGB colour gamut measured at just 70%, edging the Switch only very slightly ahead of cheaper, £300-400 tablets. Black levels of 0.34cd/m<sup>2</sup> are a little high for our liking too, especially for a device that will likely find itself in a variety of locations where clarity is essential. The



## The tablet and keyboard dock securely with magnetic prongs, making it one of Acer's better attempts at a locking system. It's not perfect, though

glossy screen coating also means outdoor usage is mostly out of the question, at least in direct sunlight, although it's still a lot better than other budget tablets.

Whereas the Surface 3 makes do with an entry-level Atom processor, the Aspire Switch 11 V has one of Intel's low-power Core M chips. The dual-core, 800MHz M-5Y10c CPU has an absolute maximum Thermal Design Point (TDP) of 6W, but because there are no fans, the tablet gets surprisingly hot even when idling in Windows, almost to the point of being uncomfortable to hold. This goes some way to explain the abysmal battery life,

which we measured at 4h 30m in our moderate usage test. Even under lighter loads, anything more than four hours was starting to push things. This is disappointing, especially when you consider the Core M processor is meant to be energy-efficient, and the fact that this is a device that would otherwise be well-suited to travelling around with.

### SNAPPY VALLEY

At least performance is good. Windows feels snappy and media-heavy web pages load surprisingly quickly, with no judder as you scroll around them. We don't run our full 4K benchmarks on Core M machines, so we ran

our lighter 1080p tests instead. An Intel Core i3-4030U laptop chip scores a benchmark score of 100. The Aspire Switch 11 V managed an overall score of 93, including an outstanding score of 138 on the short burst-focused image-rendering test.

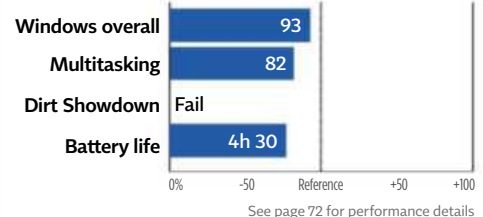
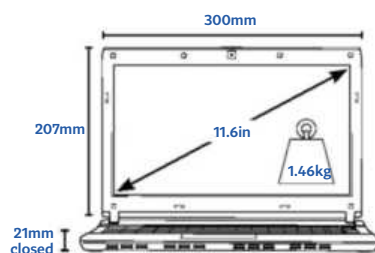
With Intel's integrated HD Graphics 5300, the Switch was never going to be adept at gaming. Most 3D titles are far beyond its capabilities, but the likes of Hearthstone and Minecraft: Windows 10 Edition play just fine.

We can't help but feel slightly let down by the Aspire Switch 11 V. On the face of it, it's a good-value 2-in-1 with a great keyboard dock and decent performance. However, things fall apart in the energy-efficiency stakes, which is where a light 2-in-1 should shine. Under five hours of battery life is unacceptable, as are the roasting temperatures on the rear of the tablet. It's frustratingly close to greatness, but the Aspire Switch 11 V just falls short.

*Michael Passingham*

## SPECIFICATIONS

**PROCESSOR** Dual-core 800MHz Intel Core M-5Y10c  
**RAM** 4GB  
**SIZE** 300x207x21mm  
**WEIGHT** 1.5kg  
**SCREEN SIZE** 11.6in  
**SCREEN RESOLUTION** 1,920x1,080  
**GRAPHICS ADAPTOR** Intel HD Graphics 5300  
**TOTAL STORAGE** 128GB SSD  
**OPERATING SYSTEM** Windows 10  
**PARTS AND LABOUR WARRANTY** One year RTB  
**DETAILS** www.acer.co.uk  
**PART NUMBER** SW5-173



## TOUCHSCREEN GAMING LAPTOP

# LENOVO Y70 Touch



£1,100 inc VAT • From [www.currys.co.uk](http://www.currys.co.uk)

### VERDICT

**A big and bold gaming laptop with decent performance, but old hardware**

**LENOVO HAS BEEN** rather consistent with its gaming laptops, at least in terms of design, and that continues with the Y70 Touch. Like some of its predecessors, the Y70 combines a nearly all-black chassis with flourishes of red adorning the keyboard and speakers, including gamer-friendly red LED backlighting.

Open the brushed metal lid and you'll find the palm rest and areas around the keyboard have a soft-touch rubber coating, which should create grip without turning your palms sweaty. The palm rest is comfortably large, too, so you won't necessarily have to plug in an external keyboard for serious gaming.

The full-size keyboard has a chiclet design, with each of the keys backlit at two different brightness levels, or turned off altogether if you prefer. The red glow illuminates the edge of each key, making it possible to type (or play) in the dark, but the keyboard layout feels rather cramped. This isn't a major problem if you're only using the WASD keys, but it could take a while to get used to typing on it.

The numeric keypad is packed too closely to the main keyboard area, which means the backspace and enter keys are easy to miss. A more thoughtful keyboard layout would have alleviated these issues, especially as there isn't exactly a lack of space on the 17.3in chassis. Key travel is at least decent, so once you hit your stride typing becomes more fluid.

### GESTURE POLITICS

The touchpad is a decent size, and we found it refreshingly responsive. It handles multifinger gestures without any hitches and has a pleasant surface to swipe upon, so using it isn't a source of frustration, as other laptop touchpads can be. There are integrated left and right buttons at the bottom and a clear distinction between the two, something that can be irritatingly missing on other laptops. You also have the option to prod away at the



17.3in touchscreen, but not many will want to do that. While Windows 8.1 and Windows 10 make for a more enjoyable touch-based experience, the laptop's hinge simply isn't rigid enough, meaning the gigantic screen wobbles with every touch input. The hinge is small relative to the display, meaning even less stability.

The screen is respectable, and at least on a par with other gaming laptops we've tested. Black levels of 0.34cd/m<sup>2</sup> and brightness of 319.4cd/m<sup>2</sup> are around what we expect, as is a contrast of 930:1. Coverage of 87.5% of the sRGB gamut is par for the course, with most colours served pretty well. The 1,920x1,080 resolution is also an ideal match for the laptop's graphics capabilities; any more pixels and game frame rates would suffer.

### PACKING A PUNCH

The screen is fine for entertainment, especially gaming, and colours are punchy and vibrant. There's very little colour shift when viewing the screen on horizontal or vertical planes, too. If you're planning on playing dark and atmospheric games on this machine, the reflections caused by the glossy touchscreen coating will reduce your enjoyment a little, unless you play in a darkened room.

The Y70 ships with Windows 8.1, but a free upgrade to Windows 10 is just a download away. We tested the laptop with Windows 10 installed and didn't encounter any driver issues after the upgrade, although we did have to install the latest Nvidia drivers manually to get proper graphical performance.

The quad-core Intel Core i7-4710HQ is clocked at 2.5GHz, with the ability to boost to 3.5GHz when thermal conditions allow. This is

supported by 16GB of RAM. The Y70 scored 81 in our application benchmarks, which is decent but unsurprisingly not a patch on more expensive gaming laptops such as the Gigabyte P37W or the Asus G751JT. The Y70 will still ably handle most tasks you throw at it as a desktop replacement, though. The 256GB SSD is a decent size and should be enough to hold your most frequently used programs and games as well as a few films.

### OLD TIMER

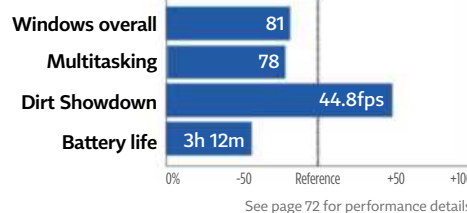
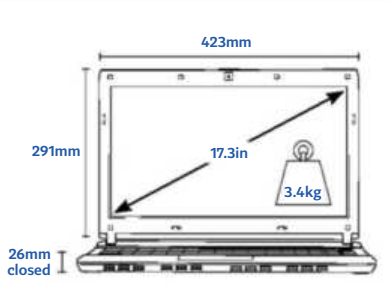
Gaming performance is provided by an Nvidia GeForce GTX 860M mobile graphics card with 4GB of memory. It's a decent enough performer, but the 860M is from early 2014. The current-generation GeForce GTX 960M is now the de facto standard for mid-range laptops and, according to our benchmarks on the similarly specified Scan 3XS Graphite LG157, is roughly 10% faster. Even worse, despite the old hardware, the Lenovo is more expensive. Yes, you get a decent looking laptop with a quality screen, but you're paying a premium. It's simply not good value.

With a spacious 17.3in display and a full-size keyboard, the Y70 isn't a laptop you'll want to carry around with you. The system weighs a considerable 3.4kg, making it unwieldy to carry. Decent build aside, this laptop isn't particularly good value unless you absolutely must have a touchscreen. The 15.6in MSI GE62 Apache is more powerful and much better value overall.

*Richard Easton*

## SPECIFICATIONS

**PROCESSOR** Quad-core 2.5GHz Intel Core i7-4710HQ  
**RAM** 16GB  
**SIZE** 423x291x26mm  
**WEIGHT** 3.4kg  
**SCREEN SIZE** 17.3in  
**SCREEN RESOLUTION** 1,920x1,080  
**GRAPHICS ADAPTOR** 4GB Nvidia GeForce GTX 860M  
**TOTAL STORAGE** 256GB SSD  
**OPERATING SYSTEM** Windows 8.1 (free upgrade to Windows 10)  
**PARTS AND LABOUR WARRANTY** One year RTB  
**DETAILS** [www.lenovo.com](http://www.lenovo.com)  
**PART NUMBER** Y70-70



Cyberpower recommends Windows.



Windows 10



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*Create The PC of Your Dreams*

Cortana available in select markets at launch, experience may vary by region and device.  
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Continuum-compatible accessory is not included, add:  
\*\*Accessories sold separately.\*\*\*App availability and experience varies by device and market. Office 365 subscription required for some features. †Limited to select premium phones at launch.  
Features and app availability and experience may vary by market and device.  
Windows Hello requires specialised hardware, including fingerprint reader, illustrated IR sensor or other biometric sensors.



**Infinity X3**  
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Work easy. Play hard. Windows

## ALL-IN-ONE COMPUTER

# APPLE iMac 21.5in (2015)



£899 inc VAT • From [www.apple.com/uk](http://www.apple.com/uk)

### VERDICT

Slightly underpowered and expensive to upgrade, but the cheapest iMac is a great all-in-one

**THE ENTRY-LEVEL** iMac often gets forgotten in the world of Retina, 5K and desk-filling displays, but the 21.5in iMac still looks the part and is one of the cheapest ways to buy a desktop computer running OS X.

For £899, you get a fabulous-looking wafer-thin aluminium chassis, complete with sharp corners, tapering backside and robust stand. The design might be practically unchanged from when it first appeared in 2012, but it still makes an impact.

The placement of ports remains frustratingly unchanged, however. Admittedly this is so the iMac can maintain its unbroken lines and svelte figure, but it means you'll have to rotate the iMac to reach the four USB3 ports, two Thunderbolt 2 connectors, 3.5mm audio jack or SD card reader.

The other aspect of the iMac that doesn't compare favourably to Windows PCs is its screen size: 24in monitors are now the norm, and 21.5in feels small in comparison. At least colours jump out of the Full HD panel with a degree of accuracy. The glossy coating means you'll occasionally see yourself reflected in darker images, but the glass does a good job of muting reflections from most sources.

Screen quality is very impressive, with wide sRGB gamut coverage and decent contrast, measured at 97.7% and 919:1 respectively. Adobe RGB coverage is much lower at 68.8%, so those working with print projects will need to look at the 4K 21.5in or the 5K 27in iMac, which both have DCI-P3 colour space panels. Enabling automatic brightness will adjust the backlight to suit the onscreen image, not the ambient light level. This can be distracting, especially if you're working on a colour-sensitive project, but it's easy to turn off in the System Preferences.

Apple continues to produce the best built-in speakers around. Impressive bass, clear mid-range and controlled treble means you won't need to augment your iMac with desktop speakers.

If you're buying a budget iMac, you should expect budget performance. The dual-core Intel i5-5250U is a notebook-spec chip, but for the most part OS X El Capitan feels as buttery smooth as ever. There are occasional hiccups when opening multiple programs at once, and multimedia tasks, while handled capably, can't compete with a desktop-class processor. It managed an overall score of



42 in our 4K benchmarks, which is respectable for a dual-core processor. The 8GB of RAM is plenty for day-to-day use, but more complex high-resolution video projects will require more. You can double up to 16GB for £160.

If you're looking for a capable all-in-one for more modest tasks and occasional multimedia use, then this base model will suit you just fine, but multimedia professionals wanting to avoid occasional Photoshop and Illustrator hangs should spend a little more on the quad-core, 2.8GHz Core i5 model.

mute buttons. It's fine for office use and general typing, but the compact size and lack of a number pad may limit its appeal to those that do a lot of number crunching.

Apple's Magic Mouse has always felt a bit stodgy compared to the firm's excellent touchpads, but the multitouch-sensitive touch surface is much more useful than a scroll wheel, particularly in OS X, which is designed with four-way swipe gestures in mind. It too gets a rechargeable battery instead of AAs. The Lightning port is on the bottom of the

## The placement of ports remains frustratingly unchanged. You'll have to rotate the iMac to reach the connectors

The integrated Intel HD Graphics 6000 can't cope with the latest 3D games, but 2D games such as Hearthstone ran smoothly. Older 3D titles will be playable at lower resolutions if you drop the detail settings.

The base specification only includes a mechanical hard disk. The 1TB capacity is reasonable, but it's disappointingly slow. If you already own a MacBook with an SSD, you'll definitely notice the speed difference when transferring files, and with no way to upgrade post-purchase you'll want to pay extra for faster storage. The £80 1TB Fusion Drive includes 24GB of SSD cache, to which OS X intelligently moves your most frequently accessed files and programs for improved performance. Alternatively, 256GB of fast flash storage will set you back £160.

The new Magic keyboard 2 is wedge-shaped, with a slightly clickier and more responsive keypress action. It finally uses a rechargeable battery, rather than AAs, and you should get around a month of use between charges. The function keys double as multimedia controls and are larger than the previous model, which is especially handy when reaching for the play/pause and

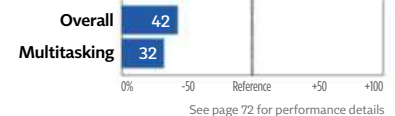
mouse, so you can't use it while it's charging, but you should get around a month between charges and around nine hours of use from a little over two minutes of being plugged in, so this shouldn't be a major problem.

The 1TB hard disk is more than a little disappointing, as is the cost of upgrading to a Fusion Drive or SSD storage, and don't get us started on the placement of the ports, but the cheapest 21.5in iMac is a capable, well-built computer. It doesn't offer the outright performance of its more expensive siblings, but it's a great way to get yourself an all-in-one with decent software and performance.

*Michael Passingham*

### SPECIFICATIONS

**PROCESSOR** Dual-core 1.6GHz Intel Core i5-5250U • **RAM** 8GB • **FRONT USB PORTS** None • **REAR USB PORTS** 4x USB3 • **TOTAL STORAGE** 1TB hard disk • **GRAPHICS CARD** Intel HD Graphics 6000 • **DISPLAY** 21.5in built-in glossy • **OPERATING SYSTEM** Apple OS X El Capitan • **WARRANTY** One year RTB • **DETAILS** [www.apple.com/uk](http://www.apple.com/uk) • **PART CODE** MK142B



See page 72 for performance details

# CHILLBLAST Fusion Drone



£500 inc VAT • From [www.chillblast.com](http://www.chillblast.com)

## VERDICT

A competent and compact gaming PC, the Fusion Drone is a bargain

**THE FUSION DRONE** is an understated and fairly compact PC, which means your money is going towards the components inside, rather than LEDs or fan controllers. The Zalman Mini T4-V2 case has front vents that look a bit like shark gills, and a small footprint. There are two USB ports on the top, although only one operates at USB3 speeds, and two 3.5mm audio jacks on the front.

The absence of a side panel window means it's not a showy build, despite the neat cable routing inside, but it's hiding some potent components. Indeed, remove the case panels and you'll find an AMD Athlon X4 860K processor inside. It's a quad-core chip that's based on AMD's A10 APU family, but lacks its own integrated Radeon graphics processor. With each of its four cores running at 3.7GHz, and the ability to Turbo Boost when thermal limits allow, it's a great choice. Chillblast has even found room in the budget to install a Corsair H55 closed-loop water cooler, with the 120mm radiator and accompanying cooling fan fitted as an intake at the front of the PC.

The Athlon X4 860K can't match top-end processors for outright speed, but an overall score of 54 in our benchmarks is decent enough for a £500 desktop. CPU-intensive tasks such as multimedia encoding and 3D rendering won't be completed as quickly as they would on a system equipped with one of Intel's Skylake processors, but you'd be

looking at paying at least another £150 for a PC with that much power.

The 8GB of DDR3 RAM is included across two DIMMs, and there's room for another two sticks of RAM if you want more memory at a later date. Windows 10 feels snappy, with web pages and programs loading without any discernible delay, so unless you're planning on undertaking some serious multimedia work, this PC will easily fulfil your needs.

## CACHE FOR QUESTIONS

There's no dedicated SSD, which is unsurprising given the price, but Chillblast has made a sensible compromise. The 1TB mechanical hard disk has 8GB of SSD cache, which should give your most-used files and programs a performance boost.

The Drone is supplied with an AMD Radeon R7 370 graphics card, which has 2GB of dedicated video memory. This is a terrific mid-range card, one that neatly undercuts Nvidia's competing GeForce GTX 960 while keeping pace in the majority of games at Full HD resolutions. In *Dirt Showdown*, the PC managed an average frame rate of 61fps.

Metro: Last Light Redux is more of a challenge. We run our standard benchmark at maximum graphical settings with SSAA turned on. At these settings, we saw an average frame rate of just 16fps, which isn't playable. Switching SSAA off, things increased to 31fps, although we found it more sensible to drop the settings by a notch just to ensure a stable frame rate. The Fusion Drone is a competent 3D gaming machine, and while the very latest titles may not run at maximum settings, you won't have to make too many compromises.

The Gigabyte GA-F2A88XM-D3H motherboard has to be small to fit into the snug chassis, and as a result lacks expansion options. The rear panel has just two USB3 connectors and four USB2 ports, and there are only three 3.5mm audio jacks for 5.1 surround sound. You do get optical S/PDIF for high-end audio kit. The lack of ports shouldn't be an issue for most people, but if you have a lot of peripherals you may want to think about buying a USB hub.

Inside, there are connectors for an additional seven SATA2 or SATA3 storage devices, though the case only has room for six. There's



room for three 2½in disks, two 3½in disks and a single 5¼ drive. The placement of the 2½in drives in particular are all over the place, with all three in completely different parts of the case. You'll need to consult the chassis manual if you're going to be fitting storage devices in the future. The one free PCI-E x1 slot is obstructed by the graphics card, but you can fit an x1 component to the x16 slot that sits just below it. There's also a legacy PCI slot at the bottom of the motherboard.

## FIVE-YEAR PLAN

Chillblast's excellent five-year warranty includes labour for the full term and a collect and return parts warranty that lasts two years.

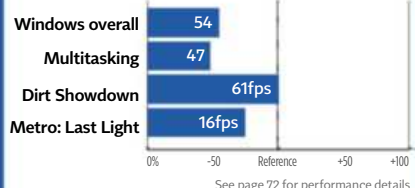
The Fusion Drone is a great little gaming PC for very little cash. You can't spend much less and still get a system capable of Full HD gaming. However, the Palicomp AMD Shockwave (see page 30) is slightly more powerful and has an overclocking processor and more video memory, giving it the edge in terms of raw value for money, although Chillblast's excellent warranty may offer that crucial extra peace of mind.

*Michael Passingham*



## SPECIFICATIONS

- PROCESSOR Quad-core 3.7GHz AMD Athlon X4 860K
- RAM 8GB
- FRONT USB PORTS 1x USB2, 1x USB3
- REAR USB PORTS 4x USB2, 3x USB3
- TOTAL STORAGE 1TB hybrid hard disk
- GRAPHICS CARD 2GB AMD Radeon R7 370
- DISPLAY None
- OPERATING SYSTEM Windows 10 Home 64-bit
- WARRANTY Five years RTB including two years of parts and two years of collect and return
- DETAILS [www.chillblast.com](http://www.chillblast.com)
- PART CODE Fusion Drone



# PALICOMP AMD Shockwave



£500 inc VAT • From [www.palicom.co.uk](http://www.palicom.co.uk)

## VERDICT

An overclocked processor and terrific graphics performance make this PC a budget hero

**BRIGHTLY LIT GAMING** PCs can be divisive, but there's no denying that the green LED colour scheme on Palicom's AMD Shockwave is distinctive. The front and rear fans both get the illumination treatment, although the case interior and components remain stubbornly dark, so you can't see the tidy cable work through the plastic side panel window.

It's fair to say there's compromise with almost every budget PC. In this case, Palicom has used an inexpensive AMD processor. The 3.7GHz Athlon X4 860K is surprisingly potent, however, and keeps Windows 10 feeling snappy. It has even had a modest overclock to 4GHz, but Palicom hasn't added any extra cooling to cope with this, sticking instead with the default AMD heatsink. This didn't appear to cause any issues in our tests, with the CPU never throttling back when under extreme load. The system comes with 8GB of RAM in two 4GB sticks, and the motherboard has two additional empty memory modules if you want to upgrade at a later date.

The AMD Shockwave scored 60 overall in our benchmarks, beating the Chillblast Fusion Drone (page 29) by six points. Windows 10 apps and web pages open with minimal delay, making this a fine everyday PC for modest users. Intense multimedia work such as HD video editing will also be possible, but expect longer render times and lower-quality video previews as the processor tries to catch up.

We were a little concerned about the stock AMD cooler, fearing the system would suffer from noise problems. While it wasn't as quiet

as the closed loop watercooler fitted to the Chillblast Fusion Drone, this turned out not to be the case; even at full pelt the whirl coming from the AMD Shockwave's case, processor and GPU fans were acceptable.

The MSI-branded AMD Radeon R7 370 graphics card manages to pack a serious punch. It isn't able to outpace slightly more expensive mid-range cards from Nvidia, but as is usually the case when budget is key, AMD wins out for systems like this.

## SHOWDOWN LOWDOWN

In our Dirt Showdown test, at Ultra detail settings and the resolution set to 1,920x1,080, the AMD Shockwave managed a respectable frame rate of 68fps. More modern titles give the card a harder time, as seen in the Metro: Last Light Redux test. With the demanding SSAA switched on, things stuttered to a 21fps average. Using SSAA is akin to doubling the display resolution, so disabling it improved the frame rate to a more playable 39fps. Dropping detail settings by a notch brought this to an even more stable 54fps, although processor-intensive physics calculations can sometimes send frame rates tumbling. With a bit of tweaking, the AMD Shockwave should be able to play modern games at Full HD resolutions. This is primarily because the MSI GPU has 4GB of dedicated video memory, instead of the 2GB you get on the Gigabyte card supplied with the Chillblast Fusion Drone.

Palicom and Chillblast have both opted for a hybrid hard disk, rather than compromise on storage space with an inexpensive yet small-capacity SSD. The AMD Shockwave has 1TB of mechanical storage, backed by 8GB of on-board SSD cache to make frequently used applications, files and games feel a little snappier. The caching process is automatic, so you don't have to worry about manually choosing which programs will benefit from it.

The Asus A88XM-Plus motherboard is extremely compact, meaning its upgrade potential is fairly limited. There are six free SATA3 connectors on the board, with four free 2½in drive bays and three free 3½in



bays inside the case for future upgrades. The 5¼in bay is occupied by a DVD optical drive.

There are two free PCI-E connectors – one x16 slot running at x4 and a smaller x1 port – as well as a legacy PCI port for older hardware.

## JACK OF ALL TRADES

Four USB2 ports and two USB3 connectors sit at the rear, alongside three 3.5mm audio jacks. There's no optical S/PDIF connector, though, so if you have expensive audio equipment, you will have to use the 3.5mm jacks. These connectors complement the two USB3 ports and two 3.5mm jacks at the front of the case.

Palicom's three-year warranty may not be as generous as Chillblast's standard cover, but it's still pretty good. You get parts cover for the first year and labour is covered for the full term. You'll pay for shipping to and from Palicom after the first seven days.

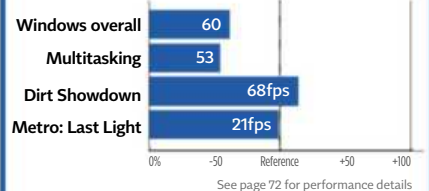
The AMD Shockwave has some stiff competition from Chillblast's Fusion Drone, and while the Chillblast's compact, stylish chassis and generous warranty is attractive, it can't match the Palicom's superior processor and better gaming performance.

*Michael Passingham*



## SPECIFICATIONS

- PROCESSOR Quad-core 4GHz AMD Athlon X4 860K (overclocked) • RAM 8GB • FRONT USB PORTS 2x USB3
- REAR USB PORTS 4x USB2, 2x USB3 • TOTAL STORAGE 1TB hybrid hard disk • GRAPHICS CARD 4GB AMD Radeon R7 370 • DISPLAY None • OPERATING SYSTEM Windows 10 Home 64-bit • WARRANTY Three years RTB
- DETAILS [www.palicom.co.uk](http://www.palicom.co.uk) • PART CODE KAV2



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## WIDESCREEN ENTERTAINMENT TABLET

# AMAZON Fire HD 10

★★★★☆

£170 inc VAT • From [www.amazon.co.uk](http://www.amazon.co.uk)

### VERDICT

A big screen and a low price, but performance and display quality leave a lot to be desired – and FireOS is restrictive

**EACH NEW TWEAK** to Amazon's tablet range has brought the Fire up to par with vanilla Android devices. The latest, the Fire HD 10, increases the screen size and is the first to run FireOS 5.0, the latest build of Amazon's custom fork of Android.

Previous versions of FireOS hid Google's operating system with oversized shortcuts and links to Amazon web stores, but version 5.0 is more refined. While books, videos, games, music and the Amazon homepage are still just a few swipes away, the default home screen now looks a lot more like regular Android. The notification area, recent apps carousel and navigation buttons haven't even been skinned, and look just like default Android.

There's still no way to add widgets, and without Google Play, there's no way to add Google's apps. Amazon has added its own Maps app, but there's no YouTube or Google Drive, and you're forced to use Amazon's Silk web browser over Chrome. Amazon's app store has more variety now, but there are still a fair few omissions, including Instagram, BT Sport and Sky Go.

That being said, Amazon's Instant Video, Music and Kindle apps are packed with content, assuming you're a Prime subscriber, and integrate with the Bing-powered search bar on the homescreen.

### SLUGGING IT OUT

It's a shame, then, that the Fire HD 10 feels sluggish as soon as you try to do anything with it. The quad-core Mediatek processor runs at up to 1.5GHz, and with 1GB of RAM it should be capable of handling basic tasks, yet some apps take several seconds to load and others simply crash or hang on launch. Closing an app and returning to the home screen, or bringing up the recent apps list, often forced the entire screen to redraw.

Bizarrely, this doesn't happen when browsing media-heavy websites, as the Silk browser is surprisingly smooth until you zoom in. A single-core score of 773 in Geekbench is only slightly behind Tesco's Hudl 2, but 1,512 in the multicore test is almost 25% slower than Tesco's tablet.

Gaming isn't the Fire HD 10's forte, either, as a score of 659, or 11fps, in the GFXBench 3 Manhattan test confirms. This is 200 points behind the Hudl 2, and well behind Google's Nexus 9. It failed to run the offscreen test, citing a lack of memory, and Hearthstone, while playable, took several minutes to load and gameplay was jerky.

Amazon has squeezed a microSD card slot on to the



side of the tablet, a first for a Fire device. It means you don't have to buy the 32GB model if you want lots of storage; buying the 16GB model will save you £30, enough for two 64GB microSD cards.

With the display brightness set to 170cd/m<sup>2</sup>, it managed a little over nine hours of continuous use, which again falls behind the Nexus 9's 12h 31m.

The 10.1in display isn't exactly show stopping. With a lowly 1,280x800 resolution, equating to a miserly 149ppi, it's easy to spot individual pixels without getting close to the screen. Small text looks fuzzy and images lack detail. The IPS panel and polarising filter work together to reduce screen glare and create impressive viewing angles, though.

### COLOUR COORDINATED

At least colour accuracy is reasonable, with an sRGB colour gamut coverage of 81.8%. A contrast ratio of 861:1 is respectable as well, although black levels are disappointingly high at 0.43cd/m<sup>2</sup>. Darker images look grey rather than black, unless you drop the brightness significantly. A peak brightness of 374.9cd/m<sup>2</sup> still falls behind other similarly priced Android tablets.

Tablet cameras rarely manage to impress, and the Fire HD 10 is no different. The 5-megapixel rear sensor has no flash and takes grainy photos lacking in detail even in bright sunshine. Outdoor shots look as though they've had an oil filter applied to them, with brickwork on buildings looking smudged. HDR improves things slightly, but it takes almost two seconds to take each image.

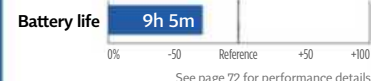
The Fire HD 10 is one of the cheapest 10in tablets around, but for good reason. Screen quality is average, performance is mediocre and you're forced to use Amazon's Fire OS. While version 5 is an improvement over previous releases, it's still limited compared to vanilla Android. Unless you're completely invested in the Amazon ecosystem, and have no need for Google apps such as Chrome, Maps, YouTube and Drive, you're signing up for a limited experience.

At £170, or £180 without ads, the Fire HD 10 is only marginally less expensive than the Nexus 9 at present, which is a massive bargain at just £200 from Argos. The Fire HD 10 was already struggling to win our affections, but the Nexus 9 is really the nail in the coffin.

Tom Morgan

### SPECIFICATIONS

**PROCESSOR** Mediatek MT8135 1.5GHz • **SCREEN SIZE** 10.1in • **SCREEN RESOLUTION** 1,280x800 • **REAR CAMERA** 5 megapixels • **STORAGE (FREE)** 16GB (12.8GB) • **WIRELESS DATA** No • **DIMENSIONS** 159x262x7.7mm • **WEIGHT** 432g • **OPERATING SYSTEM** FireOS 5.0 • **WARRANTY** One year RTB • **DETAILS** [www.amazon.co.uk](http://www.amazon.co.uk) • **PART CODE** Fire HD 10





## 8in TABLET

# ASUS ZenPad S 8.0



£170 inc VAT • From [www.currys.co.uk](http://www.currys.co.uk)

### VERDICT

**Performance and battery life are mediocre, but the design and display more than make up for it**

**ASUS KNOWS HOW** to make a great tablet while sticking to a budget – just look at the two Nexus 7s the company built for Google. For the ZenPad S 8.0, Asus has made its own decisions with regards to specification, design and, most importantly, price. On first impressions, Asus seems to have knocked it out of the park on all three counts: for £170, you get a high-resolution 8in tablet that looks gorgeous from almost any angle.

For the money, little can match the ZenPad S in terms of design. At only 6.6mm thick and weighing just 317g, it's a seriously compact tablet that's only slightly thicker than the iPad Mini 4, which costs £100 more.

Most sub-£200 tablets are made from plastic, but Asus has used metal here as well for added style points. The cross-hatched finish on the back avoids becoming a magnet for fingerprints, while the thin leather effect strip at the far edge creates plenty of grip for holding the tablet with one hand. It helps that it all looks rather stunning, too.

As the tablet is so thin, there's not much room around the edges for ports. There's a 3.5mm audio jack at the top, power and volume buttons at the side, which sit where your fingers naturally rest when gripping the tablet one-handed, and a reversible USB Type-C port on the bottom for charging.

### MICRO MANAGEMENT

The ZenPad S is available with 32GB of storage for around £200, but considering Asus has also managed to squeeze in a microSD slot, the basic 16GB model makes more sense; it costs £30 less and has enough capacity for most users out of the box, with the option to upgrade at a later date once you fill it with films, apps and music.

Sadly, the ZenPad S is underwhelming when it comes to performance. With a 64-bit, quad-core Intel Atom Z3560 running at 1.33GHz, it scored only 938 in the Peacekeeper browser benchmark. Tesco's £100 Hudl 2 scored 987, while the Google Nexus 9, currently on sale for £200, more than doubled the ZenPad S's result with a score of 2,020.

This was the case in Geekbench as well, with the ZenPad S scoring 763 and 2,311 in the single- and multicore tests respectively. The Nexus 9, meanwhile, managed 1,637 and 2,818. In practice, this means the Nexus feels slightly more responsive overall, with apps opening a fraction faster, and Android UI transitions just a little smoother. On the ZenPad S, the multitasking Recents screen takes around half



a second to open with only a few apps running, and media-heavy websites occasionally stutter or redraw when you scroll quickly through a page. These differences are only really noticeable when you have both tablets side-by-side, however, so for the most part the ZenPad S is perfectly responsive.

It's a similar story when it comes to graphics performance. The ZenPad S scored 616 in the GFXBench Manhattan onscreen test and 562 frames in the off-screen test, which is average at best. The Nexus 9, meanwhile, managed 1,385 and 1,942 frames, indicating far superior performance. The chipset Asus has used is typically paired with lower-resolution screens, and in the ZenPad S it seems to struggle to maintain frame rates at the native 2,048x1,536.

### SCREEN TO BE BELIEVED

The processor might not be lightning fast, but the ZenPad S makes up for it in other areas, most notably the screen. Asus has done a terrific job squeezing such a high-resolution panel into an affordable tablet; most rival models have Full HD screens or lower, but the ZenPad S's 2,048x1,536 matches the iPad Mini 4 and Samsung's Galaxy Tab S.

Resolution isn't everything, though, and while 76% sRGB colour gamut coverage isn't fantastic, colours certainly look vibrant. An excellent 1,549:1 contrast ratio and high 381.7cd/m<sup>2</sup> maximum brightness give images plenty of punch, and even make it possible to use the tablet outdoors without straining your eyes. Viewing angles are great, too, with only a small amount of colour shift at oblique angles. Black levels are also surprisingly low for an LCD display at 0.25cd/m<sup>2</sup>, which means dark images have real depth and definition.

The screen does take its toll on battery life, though. With brightness set to 170cd/m<sup>2</sup>, the ZenPad S could only last for a disappointing 6h 39m of video playback. This means you'll either need to reduce the brightness further or keep the charging cable with you when

leaving the house, if you want to get through an entire day and still have juice left.

The 8-megapixel camera on the rear should be a step up from the 5-megapixel or lower cameras typically found on sub-£200 tablets, and the custom camera app has a surprising number of modes and extra features including time lapse, HDR and even depth of field effects.

### IMAGE CONSCIOUS

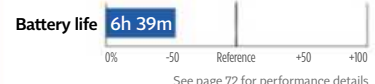
Whether shooting outdoors or inside, as long as there's plenty of light, images look clean and free from noise, with plenty of detail. There's a tendency to blow out skies and other bright subjects, and colours were a little washed out at times, but photos are still perfectly usable for social sharing. Things degraded indoors with no natural light, where noise was a bigger issue.

The ZenPad S 8.0 looks impressive on paper, costing much less than the iPad Mini 4 or Samsung's Galaxy Tab S, the two premium tablets to beat right now. On closer inspection it's clear to see why: the design may be gorgeous and the display resolution very high, but performance is only mediocre and battery life isn't great. If you're looking for a gaming tablet to take on the move, this probably won't fit the bill, but for web browsing and watching videos on the sofa, it's a great buy.

*Tom Morgan*

### SPECIFICATIONS

**PROCESSOR** Quad-core 1.33GHz Intel Atom Z3560 • **SCREEN SIZE** 8in • **SCREEN RESOLUTION** 2,048x1,536 • **REAR CAMERA** 8 megapixels • **STORAGE (FREE)** 32GB (24.4GB) • **WIRELESS DATA** No • **DIMENSIONS** 203x135x6.6mm • **WEIGHT** 317g • **OPERATING SYSTEM** Android 5.0 Lollipop • **WARRANTY** One year RTB • **DETAILS** [www.asus.com/uk](http://www.asus.com/uk) • **PART CODE** Z580C



# APPLE iPhone 6s

★★★★☆

£539 inc VAT • From [store.apple.com/uk](http://store.apple.com/uk)

## VERDICT

Unparalleled performance, but battery life isn't as good as the previous model

**FROM THE OUTSIDE**, very little has changed. The iPhone 6s is a fraction fatter and heavier than the iPhone 6, but it's had an overhaul inside; as well as a faster processor, Apple has added a higher-resolution camera and 3D Touch screen technology.

The 2015 iPhone is designed to be more durable, with a chassis made from tougher aluminium and a glass display panel made using an ion-exchange process that should make it less susceptible to cracks and scratches. This is tough to prove without long-term testing, but the glass is just as smooth under your thumb, and the curved chassis feels firm. Looks are a matter of preference, and compared to some Android handsets the iPhone is in danger of looking a little plain, but many love it for its simplicity.

The 4.7in, 1,334x750 resolution display is just as bright as the iPhone 6, at 541.75cd/m<sup>2</sup>, and blacks are equally deep at 0.35cd/m<sup>2</sup>. Colour accuracy has slipped a bit to 93.3% of the sRGB colour gamut, but the iPhone 6s still has very even coverage. Sony's Xperia Z5 has the edge when it comes to the best LCD panel, as its colours are just that bit richer, but the iPhone 6s certainly puts up a good fight. With a contrast ratio of 1,542:1, there's plenty of detail on show and viewing angles are superb. Higher-resolution phones with this screen size also look that little bit sharper.

## TOUCH OF CLASS

It's how you use the screen that's the biggest change. 3D Touch lets you press a little bit harder on the screen to access additional features, such as shortcuts on the home screen, email previews and more. In some cases, it's a genuine time-saver. Being able to jump straight to video mode on the camera feels practical. The haptic feedback is excellent, with a small buzz indicating you've pressed the screen correctly.

3D Touch supports two levels of pressure, known as Peek and Pop. In the Mail app you can press hard to Peek at an email and view more of its contents; press again and you Pop into the mail to edit it normally. It's arguably more useful in the Camera app, where you can Peek at the preview photo to make sure that you've captured a decent picture; to edit



it, you Pop to make changes. Once you get used to 3D Touch, it adds an extra dimension to the way you interact with iOS.

The new dual-core, 1.8GHz A9 processor and 2GB of RAM deliver a big performance boost over the iPhone 6, making iOS 9 feel super slick. The iPhone 6s's score of 4,417 almost doubles that of its predecessor in Geekbench 3. It's not quite the fastest phone around, though, as Samsung's Galaxy S6 edges ahead with a lead of around 500 points.

iPhones have always been more efficient web browsers than Android phones, and a huge Peacekeeper score of 4,568 only widens the gap further. The fastest Android phone, the Sony Xperia Z5 Compact, scored just 1,629. The iPhone 6s is also an unparalleled mobile gaming device, with scores of 2,474/55fps in the GFX Bench Manhattan test, putting it streets ahead of its Android rivals.

## APPLE JUICE

All this power comes at the cost of battery life. The iPhone 6 lasted almost two hours more than the latest model's 11h 18m in our continuous video playback test. It's still acceptable for a 2015 flagship, but will be disappointing if you're already underwhelmed with your iPhone's current battery life.

The camera has seen the biggest upgrade, with Apple switching to a 12-megapixel sensor that allows 4K video recording at 30fps. Exposure control is pretty similar to that of the iPhone 6, with the phone generally picking the right automatic settings for each scene.

In Auto HDR mode, it managed to capture challenging images, such as the contrast between dark streets and a bright sky, but the Galaxy S6 produced truer colours and its higher-resolution sensor captured more detail. The iPhone 6s seems to process the image more, sharpening the picture. When there's less dynamic range, the iPhone 6s does a brilliant job, capturing realistic colours and plenty of detail, with very little noise.

The iPhone 6s produces better-exposed images indoors, with auto white balance generally finding the



right setting; Samsung's camera tended to make the image a little too warm. While iPhone 6s images have a little more noise, they retain the finer detail, whether you use the dual-led True Tone flash or not. The 5-megapixel FaceTime camera on the front now has Retina flash, which uses the screen to match ambient light levels. It works well if you're trying to take a shot in a dark room.

## LIVE ACTION

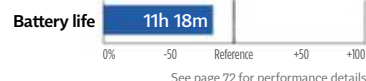
Live photos record 1.5 seconds of video before and after you press the shutter, with the clip kicking into life when you 3D Touch press on a photo to provide context. Getting the perfect live photo isn't easy; if you move the phone too quickly before or after taking a photo, you just capture a blur as the camera moves away from your subject, but when it works it's a welcome, if gimmicky, addition.

As an overall package, the iPhone 6s is a great smartphone: it's staggeringly quick, its camera is very good and iOS 9 is a brilliant and slick operating system. However, its battery life is disappointing and the screen is starting to feel a bit low-res. iPhone 6 owners won't find this a worthwhile upgrade, but those with an iPhone 5s or older will.

Katharine Byrne

## SPECIFICATIONS

**PROCESSOR** Dual-core 1.8GHz Apple A9 • **SCREEN SIZE** 4.7in • **SCREEN RESOLUTION** 1,334x750 • **REAR CAMERA** 12 megapixels • **STORAGE (FREE)** 16GB (14.7GB) • **WIRELESS DATA** 3G, 4G • **DIMENSIONS** 138x67x7.1mm • **WEIGHT** 143g • **OPERATING SYSTEM** iOS 9.0.1 • **WARRANTY** One year RTB • **DETAILS** [www.apple.com/uk](http://www.apple.com/uk) • **PART CODE** iPhone 6s



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## WATERPROOF SMARTPHONE

# SONY Xperia Z5

COMPUTER SHOPPER  
RECOMMENDED ★★★★★

£550 inc VAT •  
From [www.carphonewarehouse.com](http://www.carphonewarehouse.com)

### VERDICT

Expensive, but has the best LCD display around, superb performance and a top-class design

**SONY'S LATEST WATER-** and dust-proof smartphone has arrived just in time for Bond to use in *Spectre*. It has a 5.2in, Full HD display and the same octa-core Qualcomm Snapdragon 810 processor as the outgoing Xperia Z3+, but that's not a bad thing; the Z3+ had one of the best LCD screens around, and performance was second only to Samsung's Galaxy S6.

Instead, the Xperia Z5 gets a gorgeous updated design, with a frosted glass finish on the rear that banishes fingerprint marks. It isn't quite as slim as the Z3+, but it's more attractive, with the glass rear and rounded sides providing an unprecedented amount of grip.

The fingerprint sensor is a first for an Xperia handset, and is perfectly placed within the power button so your finger is already in the right spot when you pick up the phone. It supports multiple fingerprints, too, letting you unlock the phone no matter which hand you pick it up with. It's quick to unlock, but the small sensor area means it's more prone to mistakes than the iPhone 6s or Galaxy S6.

### GOLDEN SHOT

The final big upgrade is the 23-megapixel rear camera, the first time Sony has changed the sensor in its flagship phone since the Xperia Z1. It produces superb-looking photos, and its superfast autofocus, which Sony claims takes just 0.03 seconds, latches on to subjects almost instantaneously. Outdoor photos look great, with rich, vibrant colours and a huge amount of detail in each photo. This detail drops off slightly towards the edge of the frame, but the Z5 still produces the brightest and most attractive outdoor shots of any smartphone we've seen this year.

This high brightness has a somewhat detrimental effect indoors, though; there's barely any noise, but colours lack vibrancy and shadows aren't as dark as we would have liked. It's also a shame the placement of the fingerprint sensor bumps the volume keys to near the bottom of the phone; because the 23-megapixel sensor down-samples images to 8 megapixels, you can use digital zoom without harming image quality, but when you turn it to landscape to take a photo, you can only rest your finger on the camera shutter button or the volume keys, which double as zoom controls. On previous phones, you could reach the volume keys with your left hand, and the shutter button with your right.

The Z5's 5.2in, 1,920x1,080 display is Sony's best yet, with our colour calibrator measuring

a massive 99.4% sRGB colour gamut coverage. This is an even higher percentage than the near-perfect Z3+, which covered 98.5%.

It's a shame Sony hasn't made the jump to a 2,560x1,440 resolution panel to compete with LG and Samsung, but Full HD still offers plenty of definition on a 5.2in screen. We'd rather sacrifice pixel density for such rich and vibrant colours. The dazzlingly high brightness of 684.25cd/m<sup>2</sup> really makes colours pop out of the screen, delivering possibly the purest whites we've seen on a phone. Admittedly, this does rather murder the screen's black levels, as our reading of 0.54cd/m<sup>2</sup> can attest, but this is to be expected on such a bright display, and text still looks incredibly punchy when browsing the web. Contrast is excellent, too, even if its ratio of 1,078:1 doesn't rank among the highest scores we've seen.

### DIMMER TIME

Keeping the brightness on maximum will drain the 2,900mAh battery quickly, but it should be able to last all day if you dial it down. When set to 170cd/m<sup>2</sup>, the Z5 lasted 11h 29m in our video playback test. This is a reasonable result, only 30 minutes short of the LG G4, but the Galaxy S6 leads the pack at 13h 37m.

The Z5 supports fast charging, with five-and-a-half hours of use from just 10 minutes using a QuickCharge 2.0-compatible charger. Sony's capless Micro USB port also returns, so you can safely use the phone in up to a metre of water for 30 minutes, without fiddling with a plastic cover first. The microSD card slot is still hidden behind a flap, but then you won't need to access this every day.

A 2GHz octa-core Qualcomm Snapdragon 810 chip and 3GB of RAM makes the Z5 one of the fastest Android handsets around. With Geekbench 3 single- and multicore scores of 1,236 and 3,943, the Z5 breezes past both the LG G4 and HTC One M9, and it's not that far off the Galaxy S6's scores of 1,427 and 4,501

either. Unsurprisingly, Sony's version of Android Lollipop 5.1.1 feels very snappy.

The Z5 also has unparalleled gaming performance: 1,606 frames in the GFXBench offscreen Manhattan test is the fastest score we've seen on any Android handset, the Galaxy S6 included. This equates to roughly 26fps, and it had no problems running complex games such as *Hearthstone*. Remote Play will make the Z5 an attractive prospect for PS4 owners too, as you can use the phone as a portable display and keep on gaming if someone else wants to use the TV.

### Z'S NOT DEAD, BABY

The Xperia Z5 may have arrived too soon after the Z3+, and although Sony continues to persist with the same screen size and resolution, it's great to see the company finally moving the Z series forwards with its new fingerprint sensor and camera module.

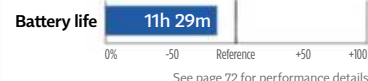
The only problem is the price. The Samsung Galaxy S6 has dropped to around £410 SIM-free or £32 per month on contract, so the Z5 looks expensive at £550 SIM-free or £37.50 per month with £20 upfront cost. As a result, the Z5 just misses a Best Buy award, but it's still one of the best Android phones around, so it comes highly recommended.

Katharine Byrne



### SPECIFICATIONS

PROCESSOR Octa-core 1.55/2GHz Qualcomm Snapdragon 810 • SCREEN SIZE 5.2in • SCREEN RESOLUTION 1,920x1,080 • REAR CAMERA 23 megapixels • STORAGE (FREE) 32GB (22.5GB) • WIRELESS DATA 3G, 4G • DIMENSIONS 146x72x7.3mm • WEIGHT 154g • OPERATING SYSTEM Android 5.1.1 • WARRANTY One year RTB • DETAILS [www.sonymobile.com](http://www.sonymobile.com) • PART CODE E6653



See page 72 for performance details

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# GOOGLE Android 6.0 (Marshmallow)

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## VERDICT

Some important changes to streamline common tasks, but headline features have yet to prove themselves

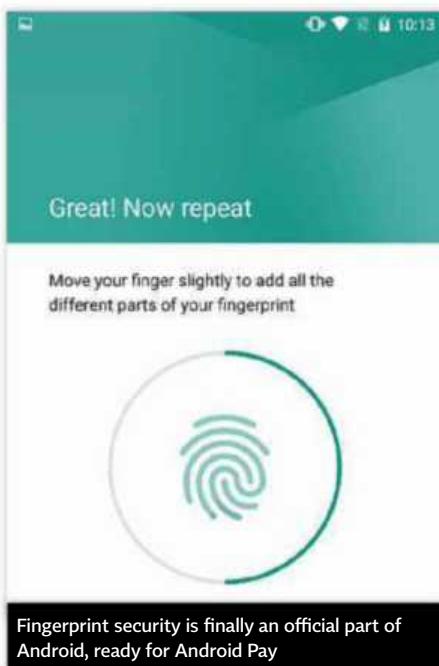
**NEW VERSIONS OF** Android used to bring sweeping changes and extra features, but the operating system is now pretty mature, and the changes in each new version have become less revolutionary and more incremental. Even so, there's enough in Android 6.0 to make it well worth having.

It's impossible to say which of Marshmallow's new features will make it to your handset, as each manufacturer has its own take on the operating system, but the biggest additions are likely to arrive intact.

Chief among them is Now on Tap, which extends the Google Now personal digital assistant throughout the OS. Google Now has been around for a while, providing pertinent information in a series of 'cards', based on your situation. Stand at a bus stop and you'll get bus times. Book a flight and it'll pull the details from your email confirmation. In Marshmallow, pressing the home button for a second at any time causes it to scan the screen and provide context-sensitive cards.

Say a friend messages you suggesting a restaurant for dinner, for example. Now on Tap will pluck out the restaurant name, link directly to the menu on its website and offer to navigate you there. It's a potentially quick and useful way to search about a topic or pull information from a message.

A less visible tweak has been made to app permissions. These can be a pain in Android, with apps presenting a huge list of permissions on installation.



In Android 6.0, app permissions are only requested when needed. The first time an app tries to access your camera, it brings up a request to do so, and you can allow this once or forever. This means you won't provide permissions for features you never use.

The set of permissions is smaller and simpler, and you can edit them by app or by permission type. The latter lets you stop all apps accessing your contacts, for example. It's not the most exciting update but it's a step forward for security and convenience.

## SLEEP CYCLE

Google has continued to make battery life improvements, this time focusing on standby power with Doze. When it detects that the device is motionless and not in use, it goes into a deeper sleep mode, polling for updates less frequently, but still being available for incoming events such as calls or VoIP. We've always found that iPads last far longer on standby than their Google-powered equivalents, so it's a welcome effort.

Security gets a bump, too, in the form of fingerprint sensor support. Many Android phones have fingerprint sensors, but Google itself has never supported them. Android 6.0 gives developers a standard set of tools for adding fingerprint support to their apps.

Finally, the new operating system is capable of running two apps side by side. We've seen this before on Samsung's Note devices, but it's never been a feature in stock Android. It will be a huge boon for users of bigger handsets, such as the Nexus 6. However, it's not yet available to most users, as it requires quite a bit of mucking about with developer settings to get it running. We hope to see it officially roll out for tablets and phablets soon.

Aside from these changes, there are some reworked classics too. The home screen looks pretty much as we remember it on Lollipop, with Google Now to the left and extra screens created on the right as you fill each with app shortcuts and widgets. The abstract, Material-influenced default wallpaper has been replaced, and the sounds for unlocking the phone and hitting the Home button are more soothing.

The App Tray is now a scrolling vertical list. Apps are still listed alphabetically, with rows of four running from left to right. It's straightforward, looks neat and the vertical design differentiates it from the horizontal design of the homescreen. There's a search bar at the top, too, which reduces the selection of possible apps as you type.



Android 6.0 doesn't look radically different to its predecessor but it's a lot nicer to use

Four suggested apps are 'pinned' across the top of the app tray. These change as you use your phone, but we couldn't work out exactly how the replacements were chosen. There's no way to change them directly, by moving or replacing them. Instead they seem to reflect apps you've used both recently and regularly, like a kind of automated favourites bar. They seem to reflect apps you launch from anywhere (mainly from shortcuts on the homescreen), rather than those you launch from the tray itself. You can still long-press any app to create a shortcut on the homescreen, view app info or uninstall it.

## TURN IT DOWN

The other change you can see on the home screen is the redesigned volume controls. Pressing up or down on the volume rocker brings up the ringer/notification volume bar. Tap the arrow icon and you can adjust the media playback and alarm clock volume from here too – either with the rocker, or simply by tapping or sliding your finger on the bar. It's better than the previous system.

The simplified volume controls mean Lollipop's Do Not Disturb feature has moved to the settings shortcut panel. Tap the icon and you can set the device to Total silence, Alarms only or Priority only, either until the mode is deactivated or a set time has elapsed.

Now on Tap and fingerprint security might be the most obvious new features in Android 6.0, but it's the efforts at streamlining that make Marshmallow better than its predecessor. Improved app permissions won't thrill enthusiasts, but more casual users will be presented with less confusing information.

The new Android isn't a blockbuster then, but a smart evolution of what's gone before and one that opens up some exciting possibilities for the near future.

Seth Barton

## ULTRA-ZOOM BRIDGE CAMERA

# PANASONIC Lumix DMC-FZ330

COMPUTER SHOPPER  
BEST BUY



£499 inc VAT • From [www.jessops.com](http://www.jessops.com)

### VERDICT

Fast, feature-packed and excellent for telephoto photography – it's how a bridge camera should be done

**THE FZ330 IS** the follow-up to 2012's FZ200 (see Reviews, Shopper 300), a ground-breaking camera with a constant f/2.8 aperture across its 24x (25-600mm) zoom. That meant it could capture lots of light in telephoto shots, reducing motion blur and noise than in other ultra-zoom cameras.

As such, it's no disappointment to find the same lens in the FZ330. The sensor is still 12-megapixels, a sensible decision given that it's just 1/2.3in. A higher resolution is likely to increase noise levels more than details in a sensor of this size.

The body is now splash- and dust-proof, and the 3in articulated touchscreen has a higher resolution than before. The electronic viewfinder is a lot bigger and uses OLED technology for deeper contrast.

The controls have been refined, too, with a command dial that's more substantial and easier to use. The manual focus switch has moved to the back of the camera, and includes an AFC option for continuously updating autofocus when tracking subjects. A new wheel on the lens barrel makes it easy to adjust manual focus, and can also be used to navigate menus and adjust settings.

### SHAKE, RATTLE AND ROLL

The FZ200 was released shortly before Wi-Fi became standard on cameras, and it's a welcome addition here. Panasonic's companion app for iOS and Android is packed with features including a remote viewfinder mode with comprehensive photographic control, video recording, stop-motion animation capture and the ability to capture a photo just by giving the phone a shake.

You can record 3,840x2,160 video at 24 or 25fps, along with 1080p at 24, 25 and 50fps. Other 4K Panasonic cameras slightly crop the frame so that each pixel corresponds directly with a photosite on the sensor. The FZ330 doesn't do this, and as a result its 4K videos don't quite have the same biting clarity. The FZ330 still excels for 1080p video quality.

The faster processor needed for 4K video capture has lowered battery life from 540 to 380 shots – disappointing, but still enough for a day's enthusiastic shooting. The upside is that continuous performance has improved dramatically. The FZ200 could shoot at 10fps but only for 13 frames before it needed to take a break to save them. The FZ330 kept going at 12.5fps for 83 JPEGs or 23 Raw frames in our test. It also captured at 7.2fps with



continuously updating autofocus, lasting for 27 Raw frames and indefinitely for JPEGs.

Autofocus performance was exceptionally fast. Shot-to-shot times averaged just 0.3 seconds. This level of performance and the fast, flexible autofocus are perfect for sports and wildlife photography.

### SENSOR ADVENTURE

The sensor itself isn't particularly remarkable – it's the same 1/2.3in size used in cheap compacts and most other bridge cameras. Comparing its output with that of the FZ200 in our studio tests, the FZ330's JPEGs at ISO 100 delivered smoother fine details such as strands of hair, with less evidence of noise in darker areas of the frame. Both cameras were flailing by ISO 3200 but the FZ330's output looked better when resized for social media sharing.

These are respectable results for a camera with a 1/2.3in sensor, but the FZ330 has much less cause to use fast ISO speeds than its direct rivals, thanks to its constant f/2.8 aperture. This means it can capture telephoto shots at ISO 400 while other cameras must go up to ISO 1600. We much prefer this to the 50x and bigger zooms offered by most rival bridge cameras, which can be unwieldy to use.

This lens was also exceptionally sharp throughout its zoom range, delivering crisp details and coping well with dense textures such as foliage and hair. It also excelled for close-up photography, as it can focus on subjects just 1m away at its full 600mm (equivalent) zoom position.

One area that left us slightly disappointed was shooting in low light at wide-angle zoom positions. Panasonic's cameras offer an Intelligent ISO mode that adapts the ISO speed not just depending on available light but also on focal length and the detection of moving subjects in the scene. This is available in the FZ330 but the settings it chose weren't always what we wanted. The slowest shutter speed it allowed was 1/60s, whereas for wide-angle shots of static subjects 1/125s gave us reliably sharp results. It's not hard to set the shutter or ISO speed manually but we'd rather not have to bother.

The FZ330 is exactly what an ultra-zoom bridge camera should be, excelling for image quality at the long end of the zoom and with elegant controls and lightning-fast performance. Nothing from rival manufacturers anywhere near this price comes close.

Ben Pitt

### SPECIFICATIONS

SENSOR RESOLUTION 12 megapixels • SENSOR SIZE 1/2.3in  
• VIEWFINDER Electronic (1,440,000 dots) • LCD SCREEN 3in (1,040,000 dots) • OPTICAL ZOOM (35mm-EQUIVALENT FOCAL LENGTHS) 24x (25-600mm) • 35mm-EQUIVALENT APERTURE f/15.6 • WEIGHT 703g • DIMENSIONS 93x133x122mm • WARRANTY One year RTB • DETAILS [www.panasonic.com/uk](http://www.panasonic.com/uk)



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# CANON EOS 760D



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## VERDICT

Well rounded, but the small viewfinder is disappointing at this price

**CANON HAS AN** SLR for every budget, and with the launch of the 760D there are now 13 to choose from. It's positioned above the EOS 750D and below the EOS 70D (*Reviews, Shopper 311*). In many respects it's a hybrid of the two.

Inside, the 750D and 760D are identical, with the same sensor, autofocus system, processor and menus. They both have a 3in articulated touchscreen and relatively small 0.51x (equivalent) optical viewfinder. They include Wi-Fi, with companion apps for iOS and Android handling image transfers and remote capture. Their performance is identical, capturing frames at 4.7fps but slowing to the speed of the card (around 1.2fps) after seven frames in Raw mode. They're responsive in normal use, capturing a photo in less than a second from switching on and at 0.4-second intervals. Shot-to-shot times in live view mode averaged one second – faster than the 70D's 2.1 seconds.

Where the 750D and 760D differ is in their physical controls. The 760D has a passive LCD screen on its top plate. This is usually the mark of an upmarket camera but unless you've used one before you might not appreciate the at-a-glance information. This one shows shutter speed, aperture and ISO speed exposure settings, battery life, shots remaining and Wi-Fi. Unlike the bigger screens on pricier Canon SLRs, there's nothing about autofocus, drive mode, white balance or metering. Then again, the 760D lacks top-mounted buttons for these settings. Instead they're located on the back, with settings displayed on the main 3in LCD screen.

The mode dial has been moved to the left side to make room, and includes a lock button to avoid accidental movement. The rear navigation

pad is encircled by a wheel. It's smaller than the substantial wheels on the EOS 70D but is easy enough to adjust. The 750D's exposure compensation button has disappeared. Instead, the rear wheel is assigned to exposure compensation in program and priority modes. However, it only becomes active after half-pressing the shutter button to prepare the camera for shooting. This caught us out a couple of times, but it avoids accidental adjustment. In manual exposure mode the rear wheel and command dial provide direct access to aperture and shutter speed.

## SIGHT MANAGER

The 760D also gains an eye-level sensor to switch the rear screen off when the camera is raised to the eye. We're always happy to see this on a compact system camera, where it also turns on the electronic viewfinder. However, the 750D's screen wasn't that distracting when it stayed on while using the viewfinder. The downside on the 760D is that you can't adjust the autofocus point using the touchscreen while using the viewfinder – possibly an accidental feature on the 750D but one that works surprisingly well.

The 760D offers all its main photographic controls via its touchscreen. Tapping the Q button turns the settings read-out into a control panel, adding options such as Picture Style preset, flash and JPEG/Raw settings. A significant drawback is that calibrating the manual white balance involves taking a photo and navigating to a menu option – this should be integrated into the white balance settings available via the WB button and Q menu. Overall, though, it's an elegant, efficient control system.

The 760D and 750D are indistinguishable for video and photo quality, and there's little to criticise. Video was clean and detailed, and Canon has finally put the clunky video autofocus of older SLRs behind it. Autofocus is easy to adjust with the touchscreen, swift to respond and virtually silent



when shooting with an STM lens. Video capture at 1080p doesn't go beyond 30fps but that's enough for most purposes.

Photo quality is up there with the best cropped-sensor SLRs. Details were sharp and natural, with no hint of noise at low ISO speeds. Vignetting and chromatic aberrations are corrected automatically for JPEGs, and the metering – which has been upgraded in this generation – rarely puts a foot wrong. Noise levels are lower than on the older Canon EOS 700D (*see Reviews, Shopper 309*), with excellent results up to ISO 6400.

## FAMILY TREE

The 760D is part of a long line of extremely competent digital SLRs. Its image and video quality are hard to fault and there are masses of superb lenses to choose from. Its controls are elegant and it works well in both live view and optical viewfinder modes. The 0.51x (equivalent) viewfinder magnification is disappointing, though, especially when compact system cameras (CSCs) are spoiling us with larger electronic viewfinders.

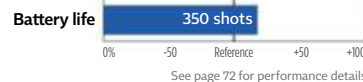
While there's nothing much wrong with this camera, we're unconvinced that the benefits over the 750D are worth an extra £100. Those looking for something more upmarket are better off with the EOS 70D. It's available for around £730 (body only), and includes a larger viewfinder, superior controls, 7fps continuous shooting and more than double the battery life. It's great to see Canon offer even more choice, but at current prices this particular choice isn't one we'd go for.

Ben Pitt



## SPECIFICATIONS

**SENSOR RESOLUTION** 24 megapixels • **SENSOR SIZE** 22.3x14.9mm (APS-C) • **FOCAL LENGTH MULTIPLIER** 1.6x • **VIEWFINDER** Optical TTL • **LCD SCREEN** 3in (1,040,000 dots) • **LENS MOUNT** Canon EF-S • **WEIGHT** 565g • **DIMENSIONS** 101x132x78mm • **WARRANTY** One year RTB • **DETAILS** [www.canon.co.uk](http://www.canon.co.uk)





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### VERDICT

Wonderful image quality and a superb operating system make this a seriously desirable TV

**THIN, SILVER BEZELS** and small legs give Panasonic's Ultra HD CX700-series TVs a premium appearance without dominating the room with unnecessarily showy design. They run Firefox OS and are packed with smart TV content, but the 55in model costs less than £1,000, making it very attractive.

This is the first TV we've seen with Firefox OS, a bright, colourful and simple smart TV system that's powerful and customisable. This is something very few TV operating systems get totally right, and with Android TV rapidly becoming more established, it was crucial that Firefox OS didn't mess this up. So far it appears to have done well.

Hitting the Home button on the remote control brings up three icons: Live TV, Apps and Devices. Live TV does what you'd expect, while Apps takes you to your smart TV apps. The Devices icon lets you pick from the other sources connected to your TV.

You can 'pin' individual channels, apps and sources, such as a games console, to the Home menu so your most-used services are just a few button presses away. It works well and we can see home cinema junkies loving



The TV comes with practically every video streaming app you could want: 4K Netflix, BBC iPlayer, ITV Player, All 4, Demand 5, Amazon Instant Video, YouTube and Wuaki.tv are all on the main screen. You'll find more apps in the Apps Market, although few are essential, aside perhaps from TuneIn Radio.

Another great feature is Freeview Play, which integrates catch-up TV with a normal TV guide, and lets you watch live content via your aerial connection. It doesn't feel quite finished yet, though. If you navigate to the left of the EPG where past shows should be, it shows you one programme for each channel – usually something popular such as *Coronation Street* on ITV1, for example. Select any past programme on BBC, ITV, Channel 4 and Channel 5 and you're taken directly to that episode's catch-up video in the relevant app (provided the show is available for viewing on catch up, of course).

Select something that's currently airing on

Fortunately, Full HD content is outstanding. A combination of perfectly judged greys and blacks, as well as local backlight dimming, makes for a natural-looking and immersive image. Colours are bright and vibrant without looking over-saturated. This is a TV you can use straight out of the box without having to change a single setting. We measured sRGB coverage of 97% at default settings.

Cinephiles who like to tinker won't be disappointed, either. The TX-55CX700B has one of the most expansive image-adjustment menus we've seen. Tweaks for every colour, MPEG noise, upscaling, interpolation, contrast, brightness and automatic adaptive adjustment are all present, among others.

Panasonic's intelligent frame creation eliminates the judder you get from 24p content, but the more smoothing you have, the more noticeable a shimmering effect there is around fast-moving objects. The Endurance spacecraft in the movie *Interstellar* suffers noticeably from what looks like deliberate heat haze from its boosters but it is in fact an artefact caused by frame creation. We'd rather have this slight noise than juddery footage, but it's down to personal taste.

The Viera TX-55CX700B is a superb 4K TV. Terrific Full HD upscaling, fantastic colours and a smooth smart TV interface gives Panasonic a huge leg-up. As Ultra HD content starts to become more readily available, this is a great TV to make sure you're ready.

Michael Passingham

## For cinephiles who like to tinker, the 55CX700B has one of the most expansive image-adjustment menus we've seen

its flexibility. The addition of a quad-core processor really helps the OS feel significantly snappier than any previous Panasonic effort.

There are some slightly more niche additions, too. Hold the Home button when watching terrestrial TV and you'll gain access to four colour-coded panels. Green activates an Accuweather forecast panel at the top of the screen, Blue opens notifications and Red reveals a list of TV channels for quick access.

Yellow opens up 'Recommended'. Here the OS presents you with a list of current programmes that you might like to watch. This didn't work all the time, though. Scroll down and you'll see a list of all the TV you've recorded, assuming you've connected an external hard disk to one of the USB ports. The third option is a selection of highlighted YouTube content. Finally, there's video on-demand, which recommends movies and documentaries from Viewster, which specialises in web shorts and animation.

the BBC, and Freeview Play will give you the option to start the show from the beginning. This is done through iPlayer's own Play From Beginning function.

Weirdly, there's no universal search function, so you'll have to use individual catch-up applications to find specific programs. Freeview says this is something it's working on for the future.

Most importantly, the image quality is fantastic. The Viera TX-55CX700B's 3,840x2,160 panel looks incredible, even in the most challenging situations. Of course, native Ultra HD content looks stunning, but perhaps more important for now is how the set handles upscaling Full HD and SD content.

As with most large TVs, there's only so much one can do with SD terrestrial TV. Blotchy, noisy and drab, it would take a miracle to make it look good. If anything, the large screen and 4K resolution emphasise the lack of quality. This TV really isn't suited to it.

### SPECIFICATIONS

SCREEN SIZE 55in • NATIVE RESOLUTION 3,840x2,160 • VIDEO INPUTS 3x HDMI (2x ARC), SCART, Component, Composite • TUNER Freeview HD • DIMENSIONS 762x1,237x242mm • WARRANTY One year RTB • DETAILS [panasonic.com](http://panasonic.com) • PART CODE TX-55CX700B

### CONNECTION PORTS



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# PHILIPS Fidelio XS1 SoundStage

COMPUTER SHOPPER



BEST BUY

£400 inc VAT • From [www.amazon.co.uk](http://www.amazon.co.uk)

## VERDICT

One of the best-looking soundplates available, with sound quality that matches its looks

## FROM HEADPHONES TO

speakers, the Fidelio range has always been home to classy-looking audio equipment. The Fidelio XS1 SoundStage is no exception. It's one of the best-looking soundplates we've seen and certainly lives up to the brand's rich heritage.

Your TV sits on top of the XS1, unlike a soundbar, which sits in front of your TV's stand. The SoundStage name is appropriate, however, as it delivers room-filling sound with aplomb. A traditional soundbar might be a welcome upgrade over the speakers built into a flat-screen TV, but their thin designs can result in lifeless sound. This isn't an issue with the XS1, as the larger speaker cabinets give audio greater impact and presence.

In spite of this, the XS1 looks thin and elegant when viewed face on. It's just 40mm tall and is strong enough to support TVs with 40-65in screens and weighing up to 44kg. The low-profile design is useful if you have a larger TV or a stand that has feet at either side rather than a single central foot, as the XS1 can slide into the space between them. There was around 10mm of clearance between the bottom of a 55in Samsung TV and the top of the XS1, but it's worth getting a ruler out to check before you buy.

There's room inside the XS1 for six full-range drivers, each delivering 20W. The left and right channels have two drivers each, one of which fires forwards and the other out to the side to widen the soundstage. The two dedicated centre channels should deliver crisp vocals and dialogue.

The speaker grille on the front face extends around the sides, with a silver accent that adds a touch of class to the edges. An LCD screen hidden behind the grille lights up to indicate the current volume level and to let you know which source is active. You can reduce its brightness or turn it off altogether if you prefer, leaving the front completely uninterrupted. The top has a glossy piano-black finish that looks stylish but has a tendency to show up dust, as all glossy objects do. Be prepared to give the surface a good wipe down occasionally.

The accompanying wireless subwoofer has an equally interesting design. It's also a large, flat platform, roughly the same size as the main



unit but slightly thicker at 90mm to accommodate the two 6½in woofers. The idea is that you can slot it under a cabinet or behind a sofa to hide it out of view. A vertical stand is included to prevent it toppling over if you can't fit it under your furniture.

Physical controls are hidden away on the side of the main unit, quite close to the back, so the included remote is a far more convenient way to control the SoundStage. This has dedicated buttons for each input

from compatible devices. There's even an NFC contact point on the front to pair Android devices with a tap.

The XS1 sounds rich and detailed, lending itself both to films and music. The side-firing speakers create wonderful stereo separation, while dialogue from the centre channels was always crisp and clear. Even in films with tricky sound mixing, such as *Interstellar*, we could hear every word easily, and we never had to enable the Voice mode. You can jump quickly

## With incredibly classy design, fantastic sound quality and bountiful connections, there's a lot to like about the XS1

source, as well as bass and treble adjustment, an EQ toggle and a Voice mode switch that emphasises the centre channel to make dialogue clearer. You can also adjust the audio delay in case there are any synchronisation issues with your TV.

For ports, the XS1 is well equipped, with an HDMI input pass-through as well as HDMI ARC for connecting to your television. We were slightly disappointed to find that the HDMI pass-through isn't HDCP 2.2 compliant for routing Ultra HD content, but that won't be a deal-breaker for most people. Connecting over HDMI ARC lets you control the XS1's volume using your TV's remote control, as well as outputting the audio from anything connected to the television. You might need to enable HDMI-CEC in your television's settings menu before the two devices will cooperate, but once you have it's a seamless experience.

There are also digital optical and digital coaxial connections, RCA, 3.5mm auxiliary and a USB port. The latter will let you connect a flash drive or external hard disk to play MP3s. Bluetooth is available, too, with support for the less-lossy aptX and AAC codecs for better sound quality

between preset EQs using the remote control, and adjustable bass and treble levels allow you to customise the sound to your taste.

The subwoofer gave the lower end some real presence, producing bass that you can really feel. Explosions had impact and weight behind them, which made watching an action-packed film such as *Transformers* instantly more exciting. The XS1 can happily replace your living room speakers for listening to music, too. Over Bluetooth, music sounded excellent, with delicate warmth and tonality across many different genres. Essentially, the XS1 sounded great with anything.

Between the incredibly classy design, fantastic sound quality and bountiful connections, there's a lot to like about the Fidelio XS1 SoundStage. At £400, it's very good value too. We've tested soundbars that cost much more but sound inferior and have fewer connections. The XS1 is an instant favourite and easily earns a Best Buy award.

Richard Easton



## SPECIFICATIONS

**SPEAKERS** 3 • **RMS POWER OUTPUT** 320W • **DIMENSIONS** 730x331x40mm • **WEIGHT** 5.3kg • **DOCK CONNECTOR** None • **NETWORKING** Bluetooth (SBC, aptX, AAC) • **WARRANTY** One year RTB • **DETAILS** [www.philips.co.uk](http://www.philips.co.uk) • **PART CODE** Fidelio XS1/12



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## 4K MEDIA-STREAMING MICRO-CONSOLE

# NVIDIA Shield Android TV



£150 inc VAT • From [www.ebuyer.com](http://www.ebuyer.com)

### VERDICT

A feature-packed media streamer that's great for games, but Android TV is still lacking

**THE SHIELD ANDROID TV** is without doubt the most highly specified media streamer to date. In fact, to call it a mere media streamer is to do it a disservice – the 4K-ready, Android TV-powered set-top box is also a games console packed with serious processing power for playing Android games, and can even stream PC titles over the internet.

Android TV is still very much a work in progress, at least where app and service support are concerned. Nvidia was forced to develop its own iPlayer app – with the BBC's blessing – but there's no Demand 5, All 4 or ITV Player. Netflix 4K streaming is a big coup, though, as the Shield TV is the first external media player to support it. You'll need a 4K TV with HDCP 2.2 support and 10-20MB broadband for uninterrupted playback, though. YouTube also supports 4K playback, and although there's no Amazon Instant Video, that's not surprising considering Amazon has its own 4K Fire TV box.

### LIMITED COMPANYY

Other apps you might expect, such as Spotify, are also missing, despite being available on Android TV-powered smart TVs. The Play Store is sparsely populated, as app developers have to make their mobile or tablet versions officially available on the big screen before you can use them, and many have yet to do so. At least the Shield TV doubles as a fully functional Chromecast, which gets round the lack of catch-up services to some extent. You can cast supported content from a smartphone or tablet, or use Plex to play media from a home server or PC.

Navigation was a seamless experience. Everything felt silky smooth and was well presented, save the occasional hiccup where preview icons didn't load. Recent or frequently accessed content is pulled in from various apps and displayed in the main screen carousel for ease of access, which is useful.

It's a shame that the Bluetooth remote is a £40 extra, as it's a far better way to get around the UI than the bundled gamepad. The large microphone search button in the middle of the remote is a godsend, as it enables you to make voice searches based around content, or make natural language requests, such as

“Oscar-winning movies from 2000” or “Who was in Training Day?” Google's own services are well represented, with YouTube, Google Play Music and Google Play Movies & TV results appearing first in any search. There's a noticeable absence of Netflix results, though, and you can't use voice search within apps.

Gaming is the Shield Android TV's real defining feature. Beyond simple titles from Google Play store, Nvidia's Shield Games hub highlights some surprising inclusions. Valve's Half Life 2: Episode 2 and Portal are available exclusively on Shield TV, and there are 'coming soon' placeholders for Resident Evil 5, Metal Gear Rising and Borderlands. Each of these games should be a great workout for the Tegra X1, an eight-core, 64-bit system-on-chip paired with a 256-core, Maxwell-based GPU and 3GB of RAM.

While it's impressive that these titles will run at all on such diminutive hardware, they were all released several years ago and aren't exactly system sellers. Aside from a few big-name releases, most of the catalogue comprises the usual casual, family friendly titles, racing games and endless runners.

The £150 base model includes 16GB of flash storage, which is likely to fill quickly if you buy games, but the microSD card slot means you can add further capacity when you need it. As such, the £220 Shield TV Pro with 500GB hard disk doesn't look like great value.

### STREAMING BLUE MURDER

GeForce Now – Nvidia's £7.50-per month take on cloud gaming – provides a better selection. The actual processing is offloaded to a server and the Shield merely relays a 1080p, 60fps stream of the action to your TV, provided you have a sufficiently fast internet connection. With a 20Mbit/s connection or higher, even titles that require fast reflexes feel almost seamless, with few compression artefacts. Again, the selection is a few years old, but it's expanding. There are also newer titles in the Buy & Play Instantly section. These are pricey, with The Witcher 3 costing £50, but many titles also include a PC copy for offline play.

Finally, GameStream lets you stream your PC games to the Shield. If your PC or laptop

has a GeForce GTX 650 graphics card or newer, and you have a wired network or dual-band, 802.11ac wireless router, you can play on the big screen as if you were sitting in front of a computer. You can even connect a keyboard and mouse to the two USB3 ports on the back of the device for strategy games or MMOs. With a gaming laptop and Shield TV connected to a 5GHz wireless network, gameplay was seamless and latency-free.

### GAME ON

The Shield TV is the best-equipped media streamer available, and 4K streaming support is a big bonus, but Android TV is still a limiting factor. Far cheaper alternatives can handle Netflix at 1080p, and Chromecast support doesn't get around the lack of services.

Instead, the Shield TV's strengths lie in gaming. There might be a lack of enticing Android content to make the Shield TV a viable gaming system, but Nvidia's three-pronged attack ensures there are multiple ways to play. GameStream in particular works well if you want to play PC games on the big screen, provided you have the necessary hardware and a capable router. GeForce Now is still in the early stages, so hopefully Nvidia can get more games developers on board and expand the number of titles. And that's before you get started with emulation, which might be legally ambiguous but there's no question the Shield TV is powerful enough to mimic even recent consoles and handhelds.

With 4K support, the Shield TV is relatively future-proof, albeit at the mercy of streaming services and their plans for Android TV. That's a gamble right now, so it may only appeal to those who want its gaming capabilities today.

*Richard Easton*



### SPECIFICATIONS

**VIDEO OUTPUTS** HDMI 2.0 • **NETWORKING** Bluetooth (SBC) • **DIMENSIONS** 210x130x25mm • **STREAMING FORMATS** UPnP (via Chromecast), Plex • **INTERNET STREAMING SERVICES** Netflix, TuneIn Radio, Google Play Movies & TV, Google Play Music, Plex • **WARRANTY** One year RTB • **DETAILS** [www.nvidia.com](http://www.nvidia.com) • **PART CODE** 945-12571-2505-102

### CONNECTION PORTS

HDMI



## AUDIO-STREAMING DONGLE

# GOOGLE Chromecast Audio

COMPUTER SHOPPER  
BEST BUY



£30 inc VAT • From [www.currys.co.uk](http://www.currys.co.uk)

### VERDICT

A supremely simple way to get audio to your speakers, and an inexpensive upgrade

**THE ORIGINAL CHROMECAST** made it easy to stream content to your TV from a host of sources. Chromecast Audio does the same for music, upgrading your speakers to internet-connected smart speakers for just £30 each.

The tiny circular device is decorated with concentric circles to resemble a vinyl record. It draws power over USB, and a mains adaptor is included if your speaker lacks a powered port.

Google supplies a short 3.5mm audio cable to get sound to your speakers. The device can also output a digital optical signal through its 3.5mm port, and you can use a 3.5mm-to-RCA cable if your sound system has no 3.5mm input. Optical and RCA cables aren't included, but the outputs mean you can connect the Chromecast to nearly any audio device.

Setup is simple. The Android or iOS app searches for any Chromecasts nearby, and once discovered, allows you to enter your wireless network details. Chromecast Audio then checks for and installs updates.

In use, the Chromecast Audio is similar to the Chromecast. Apps with native support, including Google Play Music, Pocket Casts and Rdio, have a Cast icon for instant streaming. Spotify is a recent addition and a real coup, as you can now turn any speaker into a Spotify Connect-compatible speaker. Chromecast Audio devices appear in the Spotify app, just like any other Spotify Connect device.

Chromecast Audio connects directly to each service, with your smartphone or tablet merely acting as a controller. Sound quality is never an issue, as you're not piping audio wirelessly from your controlling device.

The Chromecast app has also been updated, making it easier to discover other compatible apps. Expect the number that support casting to grow steadily over time.

You can also stream sound from any app to a speaker by casting your entire device's audio, or output the audio from a desktop Chrome browser tab with the Chromecast



extension. Latency was low enough that we could watch videos without any sync issues.

Multiroom Support is due before the end of 2015, putting Chromecast Audio up against speakers from Sonos, Samsung and LG. This means you can have the same music playing in every room around your home.

Chromecast Audio is incredibly easy to use and its low price makes it almost a no-brainer if you want to upgrade existing speakers. It's cheaper and more flexible than a Spotify Connect speaker, and will only get better once the multiroom update arrives. It's a Best Buy.

*Richard Easton*

### SPECIFICATIONS

**SPEAKERS** N/A • **RMS POWER OUTPUT** N/A • **DOCK CONNECTOR** None • **NETWORKING** 802.11ac Wi-Fi • **DIMENSIONS** 519x519x135mm • **WEIGHT** 30.7g • **STREAMING FORMATS** Chromecast • **WARRANTY** One year RTB • **DETAILS** [www.google.com/chromecast](http://www.google.com/chromecast) • **PART CODE** RUX-J42

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# GOPRO Hero+ LCD

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RECOMMENDED



£200 inc VAT • From [www.amazon.co.uk](http://www.amazon.co.uk)

## VERDICT

A great entry-level GoPro, but you might find the non-removable casing cumbersome

**GOPRO'S HERO ACTION** cameras are aimed squarely at the entry-level user, leaving the more fully featured Hero4 for serious film-makers. Despite that, the Hero is still well-equipped and more than capable of capturing quality footage. There are now three cameras in the Hero range: the GoPro Hero (around £94), the Hero+ (around £169) and the Hero+ LCD (£200). The Hero+ adds Wi-Fi for pairing with iOS and Android companion apps, while the Hero+ LCD benefits from an LCD screen.

This gives you a live view for framing your shots and playing back recorded video, but it also functions as a touchscreen. The LCD provides a quick and easy way to adjust settings and perform in-camera trimming to cut videos down to easily sharable sizes.

This is particularly handy if you plan to share footage on platforms such as Instagram, which allows only 15-second videos. You can trim video in the smartphone apps, but doing so in the camera saves you from having to transfer the full clip before trimming.

## THREE-BUTTON SUITE

The camera will feel familiar to GoPro users, with the same three-button design: a power button on the front, a shutter button on the top and a settings button on the side. You can also use the side button to mark important parts of your footage with a 'HiLight' tag when recording your video or watching it on the LCD screen, which makes editing easier.



A second, smaller display on the front shows a rudimentary menu, which is useful when the camera is mounted in a way that prevents you seeing the rear touchscreen.

One of the biggest differences between this model and the Hero4 is the non-removable waterproof case. Before the entry-level Hero arrived, every GoPro camera came with a detachable waterproof housing. With the Hero+ LCD, the case is fixed permanently in place, so you might find it a little unwieldy if you plan to use handheld gimbals designed for caseless action cameras.

The case also increases the overall size when you're not filming any aquatic escapades, although at least when you do get wet, the Hero+ LCD will survive submersion to depths of 40m. The case is rugged and will stand up to a good few knocks, too.

The Hero+ LCD weighs 127g, which is lighter than the 152g Hero4 Black. It comes with the usual array of curved and flat adhesive mounts, but the Hero+ range works with all of GoPro's existing mounts.

The camera comes with various different backdoors for the case, including one that allows you to access the touchscreen. Bear in mind that the touch backdoor is waterproof to only 10m, however. There's also a skeleton backdoor that improves sound quality by reducing obstruction to the microphones, but this isn't dust- or waterproof.

## DETAIL THERAPY

The Hero+ LCD may be an entry-level camera, but it can shoot up to 1080p video at 60fps, which is excellent for a £200 camera – many are limited to just 30fps. Where the Hero+ range is lacking is with shooting video at higher frame rates, which is useful when creating slow-motion footage. The similarly priced Veho Muvi K2 NPNG records 720p video at 120fps. You'll have to upgrade to the Hero4 Black if you want to capture 240fps video on a GoPro camera.

As well as video, the Hero+ LCD shoots 8-megapixel stills and has a burst mode that rattles off 10 frames in two seconds. There's also a time-lapse photo mode, which can shoot at intervals of between 0.5s and 60s.

One of our favourite GoPro features is the QuikCapture function. This lets you turn on the camera and begin capturing video or timelapse images quickly by pressing or holding the shutter



button when the camera is off. Another press stops the camera and turns it off again.

Outdoor footage captured on the Hero+ LCD was very crisp and sharp, with vibrant colours. Noise levels were reasonable under low light, with the auto low-light function adjusting the frame rate dynamically to match the conditions. The resulting 8-megapixel stills captured a surprising amount of detail.

For sound it has only a mono microphone, but audio was perfectly acceptable for general footage. Those who want more professional results would be better served by the Hero4, as none of the entry-level Hero cameras supports external microphones.

Battery life is excellent, matching that of the Veho Muvi K2 NPNG – one of the longest-lasting action cameras we've tested. Shooting 1080p video at 30fps, the Hero+ LCD managed a fantastic 2h 27m – significantly longer than the GoPro Hero4 Black. The battery can't be removed, however, so you can't swap it out while in the field.

As an entry-level GoPro, the Hero+ LCD is an excellent choice provided you don't need the more advanced features of the Hero4. With little difference in price between the basic and LCD versions of the Hero+, the added convenience of a touchscreen is worth paying extra for.

The Muvi K2 NPNG comes with more accessories (and supports GoPro mounts) but the Hero+ LCD has better image quality and a superior companion app. Whichever you choose, however, you'll get a very capable action camera for not a lot of money.

*Richard Easton*

## SPECIFICATIONS

SENSOR Not disclosed • SENSOR PIXELS 8,000,000 •  
MAX RECORDING RESOLUTION 1080p (60fps) • AV  
CONNECTIONS None • DIMENSIONS 54x70x37mm •  
WEIGHT 127g • WARRANTY One year RTB • DETAILS  
[www.gopro.com](http://www.gopro.com) • PART CODE Hero+ LCD





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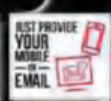
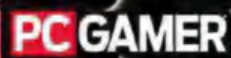
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## A3 MULTIFUNCTION PERIPHERAL

# HP Officejet 7510



£95 inc VAT • From [www.ebuyer.com](http://www.ebuyer.com)

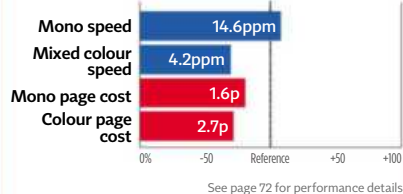
### VERDICT

The Officejet 7510 is a cheap way to print on A3 paper, but it made us grumpy

**FOR JUST UNDER** £100 the Officejet 7510 can scan, fax and copy A4 originals, and print with or without borders on anything up to A3+ (322x475mm). It supports wired and wireless networking, and is controlled via a colour touchscreen, plus there's a 30-page automatic document feeder (ADF) on the top for making unattended copies and faxes.

### SPECIFICATIONS

**TECHNOLOGY** Thermal inkjet • **MAX PRINT RESOLUTION** 4,800x1,200dpi • **MAX OPTICAL SCAN RESOLUTION** 1,200x1,200dpi • **DIMENSIONS** 287x615x727mm • **WEIGHT** 13kg • **MAX PAPER SIZE** A3+ • **WARRANTY** One year RTB • **DETAILS** [www.hp.co.uk](http://www.hp.co.uk) • **PART CODE** G3J47A



This is a chunky device, with a strong 250-sheet paper tray in the base. The tray's heavy-duty lid also forms the 75-sheet output tray, but we found it fiddly to fit.

HP's setup program installs HP's over-simplified scan interface. There's a lack of advanced features, and a limited selection of pre-defined scan resolutions. Like some other HP products we've tested, scanning at 1,200dpi produced a completely black image.

The print driver is similarly over-simplified. You'll need to fish around in its Advanced settings to find options such as the maximum print resolution. Bizarrely, you'll also need to head here to select the A3 and A3+ paper sizes that are this MFP's key selling point. Unfortunately, the Officejet 7510 doesn't support duplex prints, scans or copies.

These frustrations are a shame, because the printer's mono and colour photocopies are excellent, black text is superb, and colour graphics and photos are also pretty good. Document scans were fine, but our 600dpi



photo scan appeared to have been sharpened, leaving colour boundaries looking artificial.

This is quite a rapid MFP, managing to print both draft and standard quality text at 14.6ppm in our tests; the results looked identical, too. Preview scans took just 10 seconds over a USB connection, a 300dpi A4 scan took 13 seconds, and our 600dpi photo just 24 seconds. Single photocopies were swift, but the substantial-looking ADF buzzed irritatingly in use, slowed a 10-page mono copy to two and a half minutes and needed 45 seconds longer for the same job in colour.

Using the available high-capacity ink cartridges, this printer's running costs come in at a reasonable 4.3p per A4 page of text and colour graphics. Unfortunately, this isn't enough to save the Officejet 7510 when for the same money you can buy Brother's MFC-J5320DW. The latter may be uglier, but it's quicker, cheaper to run, and has duplex printing. It's also less frustrating to use.

*Simon Handby*

## INKJET MULTIFUNCTION PERIPHERAL

# EPSON EcoTank ET-4550



£361 inc VAT • From [www.lambda-tek.com](http://www.lambda-tek.com)

### VERDICT

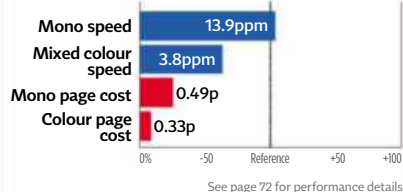
Eye-wateringly expensive for a simple inkjet MFP, but low ink costs could make up for it

**ECOTANK IS EPSON'S** range of printers that use refillable ink tanks, rather than cartridges. The ET-4550 supports both wired and wireless networking, and has automatic duplex printing.

The ET-4550's price, which puts it head to head with HP's peerless Officejet Pro X476dw,

### SPECIFICATIONS

**TECHNOLOGY** Piezo inkjet • **MAX PRINT RESOLUTION** 4,800x1,200dpi • **MAX OPTICAL SCAN RESOLUTION** 1,200x2,400dpi • **DIMENSIONS** 241x515x360mm • **WEIGHT** 7.4kg • **MAX PAPER SIZE** A4/legal • **WARRANTY** One year/50,000 pages RTB • **DETAILS** [www.epson.co.uk](http://www.epson.co.uk) • **PART CODE** C11CE71404BY



may look like a typo, but this printer comes with two sets of ink bottles that should last for 11,000 pages. When they do run out, new ink is so cheap that the cost per page is a tiny 0.49p.

The system isn't without its frustrations. While you don't have to remove this MFP's tanks to fill them, you still have to be careful to empty the right bottle into the right tank. You also need to check ink levels manually.

The ET-4550 has a 35-page ADF for unattended faxes or copies, and a button-based control panel with a simple mono screen. It delivers black text at 13.9ppm, or an impressive 23.1ppm in draft mode. At 3.8ppm, its colour graphics speed was fair. Thanks to a lethargic ADF, a 10-page mono copy took three minutes, with a further 30 seconds needed for colour. Faint draft text aside, we've no criticisms of the ET-4550's print quality, and despite the lack of borderless printing its photos were surprisingly good for an office device. Scans more than lived up to Epson's



usual high quality, with accurate focus and colours, and exceptional dynamic range.

Based solely on purchase price, features and performance, we'd much rather have HP's Officejet Pro X476dw. However, the ET-4550 is more fairly compared to a mid-range home office inkjet, such as Epson's own WorkForce WF-3620DWF. While the latter costs around £250 less to buy, its 5p-per-page ink costs mean that within about 6,000 pages the ET-4550 would work out cheaper.

Even so, we've two reservations about recommending the ET-4550 to those looking for long-term low ink costs. While Epson's reliability is good, a failure outside this MFP's one-year warranty could leave you with lots of unusable ink before you've recouped its purchase premium. More importantly, it's still not a brilliant MFP; we're not sure why Epson doesn't just make EcoTank standard across the WorkForce range, and take over the world.

*Simon Handby*

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# How to... Extend wireless range

**WIRELESS ROUTERS HAVE** much better range than they used to, but sometimes even the best router will leave your home with dead spots and slow speeds. It's not always possible to run cables around your house, so sometimes the best course of action is to use a wireless extender.

Here we show you how to use the DrayTek AP-900 dual-band 802.11n extender to improve your wireless range. We'll also show you how to set it up in access point mode in order to enhance the capabilities of your current router or to add Wi-Fi to a Powerline network.

## THE EXTENDER

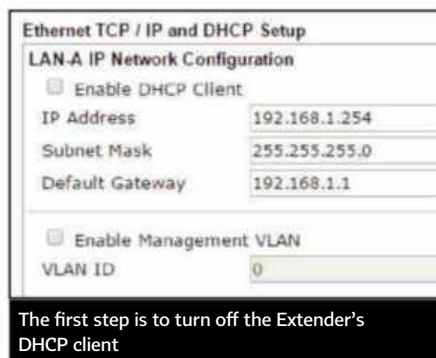
The DrayTek AP-900 can be used in both Access Point (AP) and Universal Repeater modes. Access Point mode is useful for adding dual-band wireless to routers that only support 2.4GHz Wi-Fi. You can also plug the access point into a Powerline networking adaptor in order to spread Wi-Fi further through your home.

## BEFORE YOU START

Universal Repeater mode is for when you want to extend your wireless range without having to run Ethernet wires around. The AP-900 will connect to your wireless router and rebroadcast its signal; simply connect to the AP-900 instead of your router for improved network speeds.

The DrayTek access point supports both 802.11n 2.4GHz and 5GHz, but it can only repeat one frequency in Universal Repeater mode. If most of your kit supports 5GHz Wi-Fi, you should extend this frequency, as you'll get much better throughput.

Before you start, it's useful to find out your router's IP address. Press Windows-R and type 'cmd', then type 'ipconfig'. Your



router will be listed under Default Gateway. Note down this IP address.

For the initial setup, you'll need to plug a PC or laptop into the access point using an Ethernet cable. Don't plug the access point into your router (as per the AP-900 instruction manual) as it will then lease an IP address from your router and it will be difficult to find it on your network.

Instead, you first need to assign a static IP address to the computer you're going to use for setup. To do this, press Windows-R to bring up a Run dialog, type 'control netconnections' and press Return. Right-click the Ethernet connection you're going to use to connect to the AP-900 and select Properties.

Scroll down to Internet Protocol Version 4 and double-click to open it. Tick the 'Use the following IP address' radio button, and in IP address enter 192.168.1.9. In Subnet mask enter 255.255.255.0. Don't worry about any of the other fields. Click OK and OK again.

Now plug your computer into the access point's 'A1' port with an Ethernet cable. Open your web browser and type 192.168.1.2 into the address bar - this is the AP-900's default web address. You'll need to enter a username and password, which is 'admin' and 'admin'.



↑ The DrayTek AP-900 dual-band 802.11n extender can help improve your wireless range

## QUICK START CONFIGURATION

The first step is to disable the AP-900's DHCP client, and give it its own IP address. In the left-hand pane, go to LAN and General Setup, then under 'LAN-A IP Network Configuration' untick the 'Enable DHCP Client' box. Now, give the IP address as 192.168.1.254 (this is highly unlikely to clash with anything on your network), the Subnet Mask as 255.255.255.0 and the Default Gateway as 192.168.1.1. You may find your router has the IP address 192.168.0.1, in which case you will need to use the IP address 192.168.0.254 and the Default Gateway 192.168.0.1. Click OK and OK again at the warning that pops up.

Next, you'll want to use the Quick Start Wizard. This will take you through setting up how the router behaves across the 2.4GHz and 5GHz bands. First we'll set the AP-900 up to extend your existing wireless network. As noted above, the AP-900 can't extend 2.4GHz and 5GHz networks simultaneously. Unless you have older 2.4GHz-only devices you need to connect, you should set the AP-900 up as a 5GHz extender.

Click the Quick Start Wizard link on the left. The first screen sets up the AP-900's 2.4GHz network. We won't be extending a 2.4GHz network, so leave this alone and click Next. You won't need to set up the AP-900's 2.4GHz wireless, either, so click Next again.

You'll now be in the 5GHz settings, which is where you want to be. First change the Operation Mode to Universal Repeater. Now next to AP Discovery, click the Display button, then in the window that appears click Scan.

This will display a list of wireless networks in the vicinity, along with the type of wireless




SSID	BSSID	RSSI	Channel	Encryption	Authentication
DPWeb	06:18:1a:f4:85:90	23	36	TKIP/AES	Mixed(WPA+WPA2)/PSK
DPL	02:18:1a:f4:85:90	26	36	TKIP/AES	Mixed(WPA+WPA2)/PSK
DP-Guest	0e:18:1a:f4:85:90	23	36	TKIP/AES	Mixed(WPA+WPA2)/PSK
Linksys28848_5GHz	c0:56:27:73:f9:21	100	40	AES	WPA2/PSK
pcpro5g	c4:04:15:3b:e7:a3	83	44	AES	WPA2/PSK
DAVE_ADSL_5GHZ	64:66:b3:3a:c8:16	94	48	AES	WPA2/PSK
DPL	02:18:1a:f4:87:50	99	48	TKIP/AES	Mixed(WPA+WPA2)/PSK
DPL	02:18:1a:f4:50:50	100	104	TKIP/AES	Mixed(WPA+WPA2)/PSK
DPWeb	06:18:1a:f4:50:50	100	104	TKIP/AES	Mixed(WPA+WPA2)/PSK
DP-Guest	0e:18:1a:f4:50:50	100	104	TKIP/AES	Mixed(WPA+WPA2)/PSK
DPL	02:18:1a:f4:86:70	100	104	TKIP/AES	Mixed(WPA+WPA2)/PSK
DPWeb	06:18:1a:f4:86:70	100	104	TKIP/AES	Mixed(WPA+WPA2)/PSK

After the scan, select the wireless network you want to extend and note down the encryption type it uses

## CONFIGURING THE AP-900 AS AN ACCESS POINT

You can also use the AP-900 as a wireless access point. This is useful if you need to upgrade a single-band router to support 5GHz wireless, or if you've extended your network to another part of the house and want to add wireless support.

First, plug the AP-900's A1 LAN port into one of your router's LAN ports. Now, go into the AP-900's Quick Start Wizard again and go through the 2.4GHz wireless sections until you get to the 'Wireless LAN (5GHz)' section. Change the Operation Mode to 'AP'. Click Next, and set the AP-900's Wi-Fi security settings. Again, we recommend WPA2/PSK mode and AES. Click Next and Finish, and wait until the configuration completes.

You'll now be able to connect to the AP-900's 5GHz network (called DrayTek5G-LAN-A) and get online. Bear in mind that the IP address you'll now need to access the web interface is 192.168.1.254. 

encryption they're using. Click the radio button next to the network you want to extend, make a note of its security type, and click the Close button. Click Next, and in the next screen select the router Security Mode and Encryption Type that you noted down from the AP Discovery scan.

If possible, we'd recommend changing your router's security mode to WPA2/PSK and AES encryption, as we found it easier to connect the AP-900 to our router when it was in this mode. Enter the password for your wireless network in the Pass Phrase box and click Next.

The final screen lets you set the encryption type and password for the extender's network, to which you will eventually connect instead of your router. We'd recommend WPA2/PSK mode, and AES encryption. Enter the password you want to use to secure the access point in the Pass Phrase box, then click Next and Finish.

Wait a minute or so for the settings to be applied; when done, the extender interface will refresh. Click on Online Status. Everything in the section at the bottom, under 'Universal

Repeater 5GHz Status', should be in green to show the extender is connected to your router. Make a note of the IP address here; you'll be able to use either this or 192.168.1.254 to connect to the AP-900's web interface.

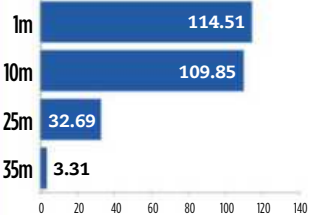
You can now connect to the AP-900's Wi-Fi network, called DrayTek5G-LAN-A, with the password you set, and get online.

Online Status				
System Status <span style="float: right;">System Uptime: 0d 04:43:26</span>				
<b>LAN-A Status</b>				
IP Address	TX Packets	RX Packets	TX Bytes	RX Bytes
192.168.1.254	391	5005	50486	1137708
<b>LAN-B Status</b>				
IP Address	TX Packets	RX Packets	TX Bytes	RX Bytes
192.168.2.2	601	0	37112	0
<b>Universal Repeater 5GHz Status</b>				
IP	Gateway	SSID	Channel	
192.168.1.138	192.168.1.1	Linksys28848_5GHz	40	
Mac	Security Mode	TX Packets	RX Packets	
c0:56:27:73:f9:21	WPA2PSK	222786	252007	

If everything in this section is green, your extender is set up and ready to go

## SPEED TESTING

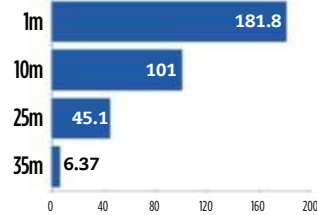
### Linksys WRT1200AC



To see how well our range extender fared, we put it up against a Linksys WRT1200AC router, and ran our usual wireless tests to calculate the wireless network's throughput. The graph above is for the router alone, connected to an 802.11n-equipped laptop on the 5GHz band.

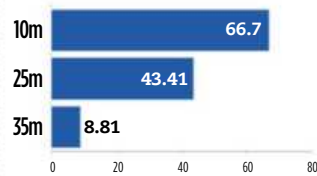
As you can see, the router performed strongly with the laptop at 10m range, but performance dropped by 70% at 25m and at 35m was a crawling 3.31Mbit/s.

### DrayTek AP-900 AP mode



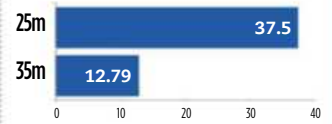
We wanted to see how the AP-900 would perform in Access Point mode, in case you want to use it to improve your router's wireless or add Wi-Fi to a Powerline network. We were surprised by how quick the access point was; it was quicker than our Linksys router at both 25m and 35m, and not far off at 10m range. A combination of Powerline plugs and some AP-900 access points would spread Wi-Fi effectively throughout even a large home.

### DrayTek AP-900 10m from router



When we put our extender 10m from the router and connected to it to our test laptop, performance wasn't as strong as if we had connected directly to the Linksys router. However, we saw stronger performance once we moved the laptop 25m away; the extender gave a useful 10Mbit/s boost at this range. Even once we'd moved the laptop a huge 35m away from the router, we were still getting 8.81Mbit/s transfers, a useful 5.5Mbit/s faster than without the extender.

### DrayTek AP-900 25m from router



For a more extreme test, we moved the extender to a position 25m from the router. With the laptop at the same distance we saw a worse result than if we had left the extender 10m from the router, but this configuration gave the best result at our extreme 35m range: an impressive 12.79Mbit/s.

# SAMSUNG 950 Pro (256GB)



£170 inc VAT • From [www.scan.co.uk](http://www.scan.co.uk)

## VERDICT

The 950 Pro is a true sign of things to come; it's the fastest, most affordable NVMe SSD yet

**SSDs HAVE GONE** from expensive and enthusiast-only to an affordable mainstream alternative to traditional hard disks in just a few short years. The transition has been so fast, and the increase in performance so drastic, that the SATA interface simply can't keep up. NVMe, or Non-Volatile Memory Express, is the specification set to replace it.

SATA was designed for mechanical storage, and even the fastest SATA3 iteration is limited to a theoretical maximum throughput of 600MB/s. NVMe, meanwhile, operates over PCI-Express and was designed from the ground up to make the most of the low latency of flash storage. It has no such throughput limitations, letting compatible SSDs reach much higher read and write speeds.

NVMe was previously only supported by Intel's enthusiast-only X99 motherboards,



M.2 storage. While you could use a PCI-Express add-in card to install the 950 Pro on a different motherboard, you wouldn't be able to use it to boot into Windows. Samsung doesn't make an official add-in card, either.

With no standardisation when it comes to motherboard layout, the location of your M.2 slot will vary between manufacturers; some companies place the slot on the rear of the motherboard, while others squeeze it in between the PCI-Express slots usually reserved for graphics cards. Either way, if you're planning on adding the 950 Pro to an existing system, you'll probably need to remove a component or two in order to reach the storage slot.

The SSD mostly comprises Samsung's second-generation, 32-layer MLC V-NAND flash storage chips, arranged in 128GB

benchmarks. We run these under Windows 10, and so the tests are affected by features such as write caching. In our huge files test, which uses files a gigabyte in size, we saw an incredible 1,349MB/s write and 2,171MB/s read speeds. This makes write speeds more than twice as fast as a SATA SSD, and read speeds almost four times as fast – there's simply nothing else out there that can match this drive for the price.

This phenomenal performance continued in the large files test, where the 950 Pro managed similar 1,349MB/s writes and 2,064MB/s reads. The small files test is typically tougher, but 1,205MB/s write and 1,646MB/s read speeds are still exceptional.

Although we've seen incredibly fast solid-state storage before, most notably in Intel's 750-series range, you needed an empty PCI-Express x4 slot on your motherboard to get the maximum performance. Now that NVMe support is becoming more common, SSDs such as the 950 Pro make a lot of sense.

If you have a system that can take advantage of its speeds, the 950 Pro is absolutely worth the premium over a SATA SSD. The 256GB model in particular is phenomenal value compared to Intel's PCI-Express-based SSDs, which cost far more for similar performance. You also get Samsung's industry-leading five-year warranty, which guarantees each 256GB drive for up to 200 terabytes written (TBW).

Anyone with an older PC will have to hold off for now, but those investing in Intel's Skylake CPUs or a top-end Haswell-E system have a new must-have component to add to their shopping list.

Tom Morgan

## Speed is the biggest reason for making the switch to NVMe, and it's here that the 950 Pro truly delivers

which are reserved for prohibitively expensive Haswell-E processors. Now that the Skylake platform has arrived, though, the standard looks set to quickly become the norm, making it the perfect time for Samsung to launch its first NVMe SSD.

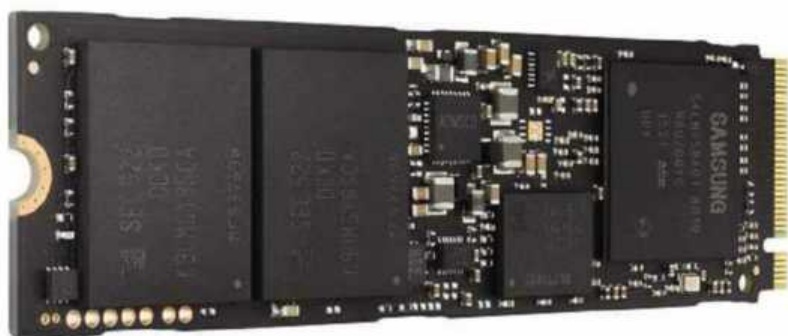
The 950 Pro is the result. It reads and writes data across four PCI-Express 3.0 lanes using the NVMe protocol to deliver extremely fast read and write speeds. It also shuns the familiar 2½in SSD format in favour of the M.2 interface, a much smaller package that will fit comfortably in ultra-thin laptops as well as desktop PCs.

The M.2 2280 form factor makes this one of the largest M.2 SSDs available, but it should fit on any X99 or Z170 motherboard. Importantly, these are the only motherboards that support booting from PCI-Express-based

modules, with space for the UBX controller alongside them. The V-NAND modules are stacked vertically to fit in a smaller space, and in turn use less power than 2D planar NAND. M.2 SSDs draw power directly from the motherboard, unlike SATA drives, which need separate SATA power and data cables. In a desktop PC, this will free up space inside the case and stop cables from obstructing airflow.

Speed, of course, is the biggest reason for making the switch to NVMe, and it's here that the 950 Pro truly delivers. It exceeded Samsung's claims of 900MB/s writes and 2,200MB/s reads in the ATTO synthetic storage benchmark, producing 958MB/s and 2,297MB/s respectively.

Real-world file transfers don't necessarily match up to synthetic tests, but the 950 Pro continued to impress in our custom storage



### SPECIFICATIONS

- CAPACITY** 256GB • **COST PER GIGABYTE** 66p •
- INTERFACE** M.2 (2280)/NVMe • **CLAIMED READ SPEED** 2,200MB/s • **CLAIMED WRITE SPEED** 900MB/s •
- WARRANTY** Five years RTB • **DETAILS** [www.samsung.com/uk](http://www.samsung.com/uk) • **PART CODE** MZ-V5P256BW

<b>Huge files overall</b>	1,760MB/s
<b>Large files overall</b>	1,706MB/s
<b>Small files overall</b>	1,425MB/s

0% -50 Reference +50 +100  
See page 72 for performance details



**KeySonic™**  
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Small sized keyboards  
for your full satisfaction...



**KSK-3022BT**

### Mini Bluetooth (3.0) Keyboard

The **KSK-3022BT** is a wireless mini keyboard with bluetooth transmission for up to 10 m away from the PC. The keyboard is compatible with almost all major operating systems - Mac OS, iOS, Android or with the conventional versions of Windows to Windows 8.



**KSK-3211BTM**

### Super Mini and wireless Keyboard

The **KSK-3211BTM** is very slim and small, but still offers all common characters and symbols besides a NumPad. It features eight multimedia hotkeys, the mouse function in the form of a trackball and two mouse buttons complete the picture of the keyboard.



## Prepared for every outdoor mission

This external enclosures for 2.5" SATA hard disk or SSD protects data against dust and splash water. For users who are outside quite often but who don't want to be without their memory capacity, this case is a perfect solution! The modern USB 3.0 connection provides for a rapid data transfer between terminal and drive. Storage packages are transferred with a speed up to 5 Gbit/s. Even the new chip set supports the speed of SATA III.

**IB-278U3 with IP54**



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- Windows & Mac compatible

## MID-RANGE GRAPHICS CARD

# NVIDIA GeForce GTX 950

COMPUTER SHOPPER  
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£140 inc VAT • From [www.ebuyer.com](http://www.ebuyer.com)

### VERDICT

Powerful without being power-hungry, Nvidia's new cut-price champion is ideal for 1080p gaming

**NVIDIA HAS HAD** the high end of PC graphics pretty much to itself for some time now, with powerful cards such as the GTX 980 Ti wiping the floor with the AMD competition. It's not quite the same with less expensive mid-range cards, though; AMD typically has the value-for-money advantage once prices drop below £150. Nvidia is looking to put a stop to that with the GeForce GTX 950, a new mid-range GPU aimed at those still using older graphics cards that want to play modern titles at 1,920x1,080.

The GTX 950 is based on Nvidia's GM206 GPU, which was first seen in the GTX 960. Although the underlying architecture remains the same, using a 28nm process, Nvidia has reduced the number of CUDA cores from 1,024 in the GTX 960 to 768 here. There are also fewer texture units: 48 rather than the 64 found in the GTX 960. Interestingly, while the card's 1,024MHz core clock is lower than the GTX 960's 1,126MHz, the GTX 950 can actually boost higher than the more expensive card, to 1,188MHz, compared to the 960's 1,178MHz.

The card's 2GB of GDDR5 RAM is just enough to run modern AAA titles. The RAM



reference design card for reviewers.

The 256mm-long card is one of the biggest GTX 950s currently available, and it needs its bulk to make room for the twin-fan ACX heatsink.

If you have the room inside your case for it, however, there's no denying the cooling system is effective. The fans don't spin up at all until the GPU hits 60°C, meaning that it's completely silent on the Windows desktop and when playing less demanding games. The fans didn't spin up to noticeable levels at any point during our testing, with the three-heatpipe heatsink proving incredibly effective at taking heat away from the GPU without serious intervention from the fans.

With a base clock pushed up from 1,024MHz to 1,190MHz and boost clock going from 1,188MHz to 1,393MHz, the EVGA card has roughly a 15% speed boost over Nvidia's

Redux was just below what we'd judge playable with SSAA enabled, averaging 26.6fps, but disabling this and dropping tessellation and texture details from maximum to high boosted the frame rate to 64.9fps. The AMD Radeon R9 370, the GTX 950's closest competitor, is between 5% and 10% slower across the board, if around £25 cheaper.

At higher resolutions, you may not be able to run the latest games at their highest graphical details and stay above 60fps, but if you're prepared to make a few detail level compromises, gaming at 2,560x1,440 is certainly possible. Unsurprisingly, the four-year-old Dirt Showdown fared best at this resolution, with 50.4fps, meaning you only have to disable anti-aliasing to get over 60fps. Tomb Raider wasn't far behind, though; we saw 47.8fps with FXAA enabled, a big improvement over the 22.5fps average with SSAA turned on. Metro: Last Light was the toughest challenge, as with SSAA enabled we saw only 14.8fps. Turning SSAA off helped improve things to a just-playable 29.2fps. Again, the GTX 950 outperforms the Radeon R9 370, although the gap begins to close in seriously demanding games such as Metro.

At £140, the GTX 950 looks like an absolute bargain for anyone looking to game at 1,920x1,080 for the foreseeable future. AMD's R9 370 is slightly cheaper, but was consistently slower in all our tests. It also uses significantly more power than the energy-efficient GTX 950, and lacks HDMI 2.0 for 4K output at 60fps.

You'll need to sacrifice anti-aliasing and possibly drop detail settings to stay above 60fps in the newest titles, but considering the price this is a minor concession to make. If £150 is your limit for buying a graphics card, the GeForce GTX 950 is a superb buy.

*Tom Morgan*

## Support for HDMI 2.0 means you'll be able to watch 4K content if you have a compatible TV or display

runs at an effective 6,600MHz and operates on the same 128-bit memory bus as the GTX 960, but the 105.6GB/s memory bandwidth is slightly lower than the 960's 112GB/s.

As the card has a single 6-pin PCI-Express power socket and a GPU based on the company's energy-efficient Maxwell architecture, you won't need a hefty power supply in order to run it. In fact, with a Thermal Design Power (TDP) of just 90W, the GTX 950 consumes considerably less power than any other current Nvidia GPU; even the GTX 960 has a 120W TDP.

Nvidia has also specified support for HDMI 2.0, ready for 4K video output at 60fps. It's great to see this included on a budget card, as it means you'll be able to use it to watch 4K content if you have a compatible TV or display. None of AMD's 300-series cards support HDMI 2.0, meaning you're forced to use DisplayPort or drop down to 30fps playback on an Ultra HD TV.

EVGA's GTX 950 2GB SSC was the first GTX 950 to arrive, as Nvidia didn't release a

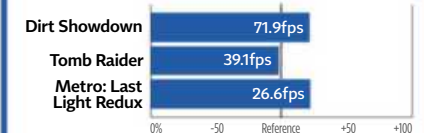
reference design. The memory also gets a small 10MHz push to 6,610MHz effective.

EVGA clearly intends gamers to overclock its GPUs, as it has fitted an 8-pin PCI-Express connector, rather than the standard 6-pin, to ensure the card gets enough power. There's even a toggle switch to alternate between two graphics BIOS chips, which contain different fan profiles for more effective cooling at higher clock speeds. It's almost overkill for a card aimed at 1080p gaming, but you can at least be sure that cooling is sufficient regardless of your clock speeds.

The GTX 950 performs brilliantly at 1,920x1,080, as long as you're realistic with detail settings and anti-aliasing – after all, this is a sub-£150 graphics card. We saw a perfectly smooth 71.9fps in Dirt Showdown, and while 39.1fps in Tomb Raider is an improvement over the Xbox One version's capped 30fps, swapping out the demanding super sampling anti-aliasing (SSAA) for the less resource-hungry FXAA resulted in 77.5fps. The GPU-intense Metro: Last Light

### SPECIFICATIONS

GPU Nvidia GeForce GTX 950 • MEMORY 2GB GDDR5 • GRAPHICS CARD LENGTH 256.5mm • WARRANTY Three year RTB • DETAILS [www.nvidia.co.uk](http://www.nvidia.co.uk) • PART CODE 02G-P4-2957



See page 72 for performance details





# How 3D-printed rats could offer schools a vegetarian dissection

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## VIDEO-EDITING SOFTWARE

# ADOBE Premiere Elements 14

COMPUTER SHOPPER  
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£79 inc VAT •

From [www.adobe.com/uk](http://www.adobe.com/uk)

### VERDICT

Its new features are a mixed bag, but Premiere Elements caters to a broad range of users

**VIDEO EDITING CAN** be demanding for both the PC and its owner; the challenge for consumer software is to make it look easy. Premiere Elements scores well in this regard, with a clean interface that's straightforward for simple tasks, but which delivers a range of sophisticated editing techniques to those who are willing to dig a little deeper.

Adobe has clearly done its research, and the focus groups have told them they want more help to unlock these advanced features. This is where Guided Edits come in, providing interactive tutorials that overlay directly on to the interface to show users exactly where to click to achieve various tasks.

There are two new Guided Edits in version 14. One shows how to convert a video to black and white except for one saturated colour. It's an attractive effect that's not easy to locate by chance. The Guided Edit goes a little further than just applying an off-the-shelf effect, as it explains how to isolate different colours.

### SECOND THAT MOTION

The other new Guided Edit explains where to find and how to use the Time Remapping tool for variable slow- and fast-motion effects. It's useful to explain the overall objective of the feature, but it can't have been much more than a few hours' work for someone at Adobe. When Guided Edits first appeared in version 12 we had hoped that new tutorials would appear every couple of months to give users something new to try. At their current rate of two per year, it's going to be many years



The new Motion Titles look the part, but editing them is fiddly

before the whole of Premiere Elements' many advanced features are covered in full.

We're relieved to see that a lot more work has gone into tidying up the export facilities. A Quick Export option generates a 720p MPEG4 file that should play on almost any device. Click the Devices, Disc or Online tab and various preset resolutions are offered, all sensibly chosen and clearly labelled. Templates go up to 4K (3,840x2,160), and the only missed trick is that the software doesn't warn users not to bother upscaling exported videos to a higher resolution than the original footage.

### EXCHANGE RATES

These export templates don't include a choice of frame rates. Instead, the frame rate is matched to the project settings, which in turn are matched to the source footage. This is as it should be, as it avoids frame rate mismatches that result in uneven motion. This is the first time we've seen it done properly in consumer software. If you're determined to alter the frame rate – perhaps to convert 50fps to 25fps – this is possible via the Custom tab, which also includes detailed control over compression and audio encoding settings. Even here, there are tick-boxes to match each setting to the source footage, so it couldn't be easier to preserve optimal quality.

Premiere Elements' keyframe automation tools allow for some sophisticated animations, but they're complex and tricky to master. New Motion Titles provide a quick fix for people who want glossy animations without the rigmarole of programming them from scratch. Various templates are arranged by theme, such as Travel, Sports and Wedding, although with just 32 in total, it won't take long before you're forced to reuse them. They're fairly attractive, but customising them proved tricky. Placeholder text can be replaced with your own words and reformatted, but in some cases the design is heavily dependent on the text fitting together neatly, and so entering custom text makes it look messy. The duration of the animations is fixed, and it's not possible to replace the background image with your own. The interface looks neater than the similar new feature in Magix Movie Edit Pro 2016 (opposite), but in use it feels clumsier.

### EASY DOES IT

In most other areas Premiere Elements takes a clear lead over Magix for ease of use. Designing a consumer editor that caters for both novices and advanced users is a tall order, but Adobe has managed it better than anyone else. It also scores highly for preview performance, with smooth previews of 4K footage on our Core i7 870 test PC. Sony Movie Studio Platinum is still our top pick, simply because its timeline controls are quicker to use, leaving more space to focus on creativity. However, Premiere Elements has a shallower learning curve for beginners, and it also goes further with advanced tools and effects. It's not the most enticing update for existing users, but the improved export facilities alone may be worth the upgrade.

Ben Pitt



### SPECIFICATIONS

**OS SUPPORT** Windows 7 (SP1), 8, 10, Mac OS X 10.9 or 10.10  
• **MINIMUM CPU** 2GHz with SSE2 • **MINIMUM GPU** DirectX 9 or 10 • **MINIMUM RAM** 2GB • **HARD DISK SPACE** 10GB • **DETAILS** [www.adobe.com/uk](http://www.adobe.com/uk) • **PRODUCT CODE** B013UNNCVW

## VIDEO-EDITING SOFTWARE

# MAGIX Movie Edit Pro 2016 Premium



£90 inc VAT • From [www.magix.com/uk](http://www.magix.com/uk)

### VERDICT

**Not short of power, but Movie Edit Pro 2016 has too many irritating habits**

**IT CAN'T BE** easy being the software product manager charged with the task of producing a new version every year. Video-editing software has to keep up with the latest video standards, but in most respects the needs of the average user don't change much from year to year. Support for the latest standards don't make for an enticing upgrade, and people expect must-have new features with each iteration.

Magix is off to a good start by bundling proDAD Mercalli v4 with this latest version of Movie Edit Pro Premium. This is the *crème de la crème* of video stabilisation, and retails at £179. It offers detailed control over processing, with the ability to correct on various axes of motion and apply lens distortion correction from a library of presets for popular action-cams from GoPro, DJI and many others.

This version of Mercalli v4 works only as a plug-in inside Movie Edit Pro, and it's a little frustrating that the pop-up editor must be closed in order to preview the results. Still, it's a small price to pay. A bigger concern is that when right-clicking a video file and selecting Image Stabilisation, it offers a choice of Magix's own stabilisation algorithm or Mercalli v2, which is also lurking in the list of video effects. Mercalli v4 is available via the Effects tab, but there's a chance users won't find it.

The Title tab includes some new templates that are unusually tasteful and sophisticated for consumer editing software. Some are simple animations, such as subtle zooms and fades, while others incorporate animated graphic elements. The latter appear on the timeline as three grouped objects: one for

text, one for graphics and a third as a mask for the graphics so the video appears behind the titles object. It's a little messy but it allows the various elements to be ungrouped and edited individually. The animations for the text elements are applied using the software's standard Fade and Size/Position tools, so they can be edited to your heart's content.

### TRANSITION VAMP

We don't often get excited about transitions, as anything other than dissolves and fade to black tend to look gimmicky. However, the new blur-based transitions are actually pretty good, using animated linear and radial blurs to segue from one clip to another. There's clearly some GPU acceleration going on, as these complex blur effects played back smoothly.

It wasn't entirely plain sailing, though. Transitions have a fixed duration, and applying them to an existing transition changed the length of the transition. Depending on the selected ripple editing setting, this caused objects on other tracks to become out of sync. At times it made titles objects on other tracks mysteriously jump to a different track, and in some cases they disappeared entirely.

The new 360° Panorama function is designed for spherical photos from cameras such as the Ricoh Theta. It provides simple controls to pan around the image and dynamically warps perspective to give a fish-eye effect. It's a niche feature but will be welcomed by some. We were also able to use it to pan around stitched panoramas, but the controls become extremely slow to

The blur-based transitions and animated titles templates are unusually stylish



respond when the software was presented with huge JPEGs of hundreds of megapixels.

It wasn't possible to export at 4K resolution in Movie Edit Pro 2015, and sadly that's still the case here. There are export templates for standard definition, 720p and 1080p, but despite the ability to edit in 4K, there's no equivalent export template. You can work around this by selecting 4K export to YouTube and retrieving the file that's created, but it's hardly an elegant solution.

### EXPORT DUTY

It's also still impossible to export 2.7K projects in MPEG4 format at any resolution. The GoPro Hero 3 Black Edition can shoot at 2.7K, which gives some useful extra pixels to maintain high quality after stabilisation processing crops the image. Movie Edit Pro helpfully sets the timeline resolution to match the first imported clip, but for 2.7K projects it offers an empty drop-down list of export resolutions in MPEG4 format.

There are lots of positives to Movie Edit Pro but, during testing, our attention was more often drawn towards its rough edges and annoying traits. As before, the interface is dominated by long lists of options in menus that make it hard to locate features. For example, the website claims to offer improved object tracking so titles and effects stay glued to subjects in the video footage, but there's no mention of tracking anywhere in the online manual. We'd almost given up looking when we chanced upon an option in the right-click menu called 'Attach to picture position in the video'. The process turned out to be simple and effective, but you'd never guess from reading the paragraphs of awkwardly worded text instructions. We doubt that most users would ever find it.

There's masses of additional content available, spanning 20 downloads totalling over 6GB, but there's also a lot of filler. We'd much rather have a leaner application with only the best, most useful functions.

Ben Pitt



It's great to have the powerful Mercalli v4 video stabilisation included with a consumer video editor

### SPECIFICATIONS

**OS SUPPORT** Windows 7/8/10 • **MINIMUM CPU** 2.4GHz (quad-core 2.8GHz recommended) • **MINIMUM GPU** 512MB recommended • **MINIMUM RAM** 2GB (8GB recommended) • **HARD DISK SPACE** 2GB • **DETAILS** [www.magix.com/gb](http://www.magix.com/gb)

## PHOTO-EDITING SOFTWARE

# ADOBE Photoshop Elements 14



£79 inc VAT • From [www.adobe.com/uk](http://www.adobe.com/uk)

### VERDICT

Photoshop Elements isn't getting any worse, but the new features are weaker than ever

**PHOTOSHOP ELEMENTS HAS** stood head and shoulders above the competition since version one, thanks to its similarities with the full version of Photoshop. However, for years it's been coasting with minimal improvements. It was only a matter of time before something overtook it, but we didn't expect it to be an inside job. With Photoshop CC and Lightroom CC now available on a subscription for £102 per year, the prospect of paying around £50 to upgrade Photoshop Elements each year is decidedly less appealing.

Adobe has hit back against itself with an update to Photoshop Elements, with the usual smattering of new features, tutorials and tweaks, but it's questionable if it's enough to tempt existing users to upgrade; many may be better off sticking with an older version, or moving to a Creative Cloud subscription.

The new Haze Removal tool will be familiar to Creative Cloud users, and makes a welcome appearance here. It analyses the image and boosts the contrast of parts of the image that have less contrast to start with, while leaving more heavily contrasted areas unaffected. For landscape shots, this processing tends to be applied near the horizon, where atmospheric haze pushes tones towards grey. There are two modes, one of which is automatic, while the other has controls to adjust the amount of processing and the threshold beyond which areas of the image are deemed to be hazy.

One thing it can't do is process Raw files directly. Unlike Photoshop CC and Lightroom CC, Elements' Haze Removal is limited to JPEGs (or Raw files after converting them to



The Dehaze tool (applied to the right half of this image) boosts the contrast only where it's needed

8-bit colour). It's not a huge limitation, but it means images are more likely to suffer from noise and colour banding after processing, especially when bringing out details in skies.

### SHAKE, RATTLE & ROLL

Shake Reduction is a common feature for video-editing software, but it's more unusual for photo editors. It's also tricky to deliver. It attempts to clean up blurry photos by analysing the shape of blurry streaks in the image and applying a complex sharpening algorithm to counteract this blur. Sadly, it's not as impressive in practice as Adobe would have us believe. Processed images looked as if they had undergone some heavy-handed digital sharpening, with halos around high-contrast lines. Noise was heavily accentuated, too, so this filter is little use for smartphone pictures. We had some success with photos from a high-quality camera taken at ISO 100, but the old Unsharp Mask filter proved to be quicker, more controllable and, to our eyes at least, gave better results.

We really like the Guided Edits in Premiere Elements (see page 58), as these interactive tutorials do a great job of revealing how to use the advanced functions the software has to offer. Photoshop Elements' Guided Edits are less successful. They repackage various

techniques in a simplified interface, so they're useful if you want to achieve the exact effect on offer, but less good if you want to transfer similar techniques to create other effects.

The new Speed Effect Guided Edit brings this problem into focus. It applies a motion blur to a selected area in a photo to suggest high-speed motion, but the results look fake. Behind the scenes, the software is doing some sophisticated edits involving masks, but users don't get to see how these are used when they follow the Guided Edit.

### REFINE WHINE

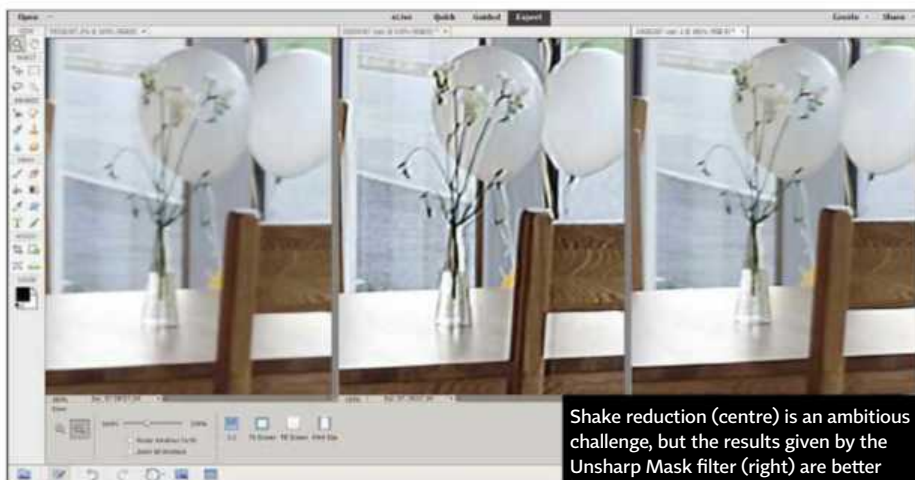
We didn't get on with the Refine Selection Brush, which is apparently enhanced in this update but still gave inferior results compared to the Refine Edge dialog in the Select menu.

The Haze Removal tool is the only thing in this update we can muster much enthusiasm for, and we wouldn't be tempted to fork out the £55 upgrade price for it. To give it a more positive spin, if you own a recent version of Photoshop Elements, you can save yourself £55 without missing out on essential features.

For new customers, it's a trickier decision choosing between this and Creative Cloud Photography Plan. The CC subscription is more expensive, and customers must keep paying or lose access to the software. However, for anyone with more than a passing interest in photography or graphic design, the Photography Plan makes a lot of sense and is tremendous value. Meanwhile, casual users are likely to be satisfied by free software such as Picasa, or free tablet apps such as Snapseed.

There is a market for Photoshop Elements, though. If you want to design invitations, create photo montages and process Raw files, but don't want to commit to spending £102 a year, it's still the best consumer image editor around.

Ben Pitt



Shake reduction (centre) is an ambitious challenge, but the results given by the Unsharp Mask filter (right) are better

### SPECIFICATIONS

**OS SUPPORT** Window 7 (SP1), 8, 10, Mac OS X 10.9 or 10.10  
• **MINIMUM CPU** 1.6GHz with SSE2 • **MINIMUM GPU** DirectX 9 or 10 • **MINIMUM RAM** 2GB • **HARD DISK** SPACE 5GB • **DETAILS** [www.adobe.com/uk](http://www.adobe.com/uk) • **PRODUCT CODE** B013UNN9N8

## CITY-BUILDING SIMULATION

# PARADOX INTERACTIVE

## Cities: Skylines – After Dark



£34 inc VAT • From [store.steampowered.com](http://store.steampowered.com)

### VERDICT

Beautiful and fun, but *Cities: Skylines* is more sandbox than simulation

**THE TOWN OF** Banff, Canada, is a bustling little holiday destination, perfect for hikers in the summer months and skiers in the winter. It's overlooked by spectacular mountains and filled with quaint holiday apartments, Irish theme pubs and gift shops. Our virtual version isn't quite so attractive. Things were going swimmingly until we built a one-way street in the wrong direction. Doing that meant bin lorries couldn't drive down it to pick up the rubbish. Garbage built up before we noticed and now everyone is dead. Lesson learned.

*Cities: Skylines* is all about screwing up, learning lessons and starting again. You're given a blank piece of land to do with what you wish. There are no planning regulations or green belts to worry about; you just build what you want, where you want. Lay roads, create zones for specific types of buildings and plopp down services (schools, parks, hospitals), and you have the barebones of a city.

From there, it's about expanding your city and dealing with issues as they arise. Most of your problems will be caused by traffic flow; sometimes it will be down to your own lack of infrastructure knowledge, but an awful lot will be caused by idiotic AI behaviour. If a vehicle's next turn is a left, it will sit in the left lane,

even if that left turn is miles away. If that turn is particularly popular, you'll have a huge traffic jam in one lane, with the other lanes



Cities can be vast: this metropolis takes up just one tile, with up to nine (or 81 with mods) available

completely clear. To an extent this will be down to poor city design, but the inability to add a second left-turn lane means that these problems are impossible to solve without creating huge, looping overpasses that, while impressive, quickly turn every major intersection in your city into a colossal mess.

Traffic jams cause huge problems for your services and citizens. Emergency vehicles get stuck in traffic with everybody else, as do rubbish lorries and hearses, so the problems caused by vehicle behaviour aren't just cosmetic: they're game-breaking.

### DARK MATTER

The addition of an optional day/night cycle in the After Dark expansion compounds these problems, revealing many shortcomings in the underlying game engine. Citizen behaviour only changes slightly at night, with buildings such as schools still lit up and students milling around in the playground. You can change how city services behave at night, for example shutting down some bus routes or only letting rubbish lorries roam around in the daytime, but your citizens don't understand this and will complain when they see there aren't any bus routes near their home – even if it's night time and they don't need to go to work.

Leisure zones are more active at night, and taxis seem more popular, but aside from these rather basic changes, very little changes when the sun goes down. That's not to say the expansion isn't worth buying; it's just that you shouldn't expect it to completely change how you play the game.

After Dark's day/night cycle gives your cities a new feel



Despite the myriad problems you'll face, it's easy to make more money than you know what to do with. Once you've set up all the basic services in your city and have a steadily growing population, it's hard to go into debt unless you mismanage your city by, for example, building an expensive, underused underground train network.

### DISTRICT LINE

This is a shame, because the game is beautiful. The developers absolutely nailed the art style, creating truly epic landscapes and skylines from a distance but sticking with a slightly more cartoon style close up. Being able to divide your city into districts makes your city feel alive, and lets you create a narrative with local by-laws that make each district different.

It makes the game a far better sandbox than a real city-management sim. We had the most fun playing with unlimited money and all buildings and services unlocked.

*Cities: Skylines* supports third-party mods via Steam's Workshop. We wouldn't have sunk 100 hours into this game without them, as many mods fix longstanding problems. There's better public transport management, the ability to time traffic lights and assign turning lanes and new buildings, along with thousands more we're yet to discover. The game relies too heavily on these mods, though. Every update is potentially mod-breaking, and you're relying on the creators to continue developing them without payment.

*Cities: Skylines* (£23) is a gorgeous game, and After Dark only costs £11. Our main concern is that without mods, you'll grow tired and frustrated with the game's limitations after no more than perhaps a dozen hours. If you're in it for the long haul, you should make yourself familiar with the various resources that list essential mods, and keep up to date with the latest changes. If you stay in tune with the community, you'll be rewarded with many hours of gameplay.

Michael Passingham



### SPECIFICATIONS

AVAILABLE FORMATS PC • OS SUPPORT Windows XP/Vista/7/8/10 • MINIMUM CPU 3GHz Intel Core 2 Duo • MINIMUM GPU Nvidia GeForce GTX 260, ATI Radeon HD 5670 • MINIMUM RAM 4GB • HARD DISK SPACE 3GB • DETAILS [www.paradoxplaza.com](http://www.paradoxplaza.com) • PRODUCT CODE *Cities: Skylines – After Dark*

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# Choosing a...

## PC system

**01** A basic PC costing around £350 will be able to run everyday office, multimedia and education software and will easily cope with the internet. It might even be able to run some modern games. Many PCs can be sold either with or without the monitor. If you don't like the display that the manufacturer is offering, you can always use your current one, or buy one separately.

**02** If you want to play games, you'll have to upgrade the graphics card. Budget cards such as the AMD Radeon R7 260X will cope well with many 3D games, but to play the latest 3D games smoothly (and enjoy the best-quality graphics) it's worth upgrading to a more powerful card such as an Nvidia GeForce GTX 960.

**03** All modern PCs come with at least a dual-core processor and are capable of most tasks. Anyone who regularly undertakes demanding tasks such as video editing and encoding should consider a quad-core or even hex-core processor.

**04** There are plenty of good reasons to upgrade the PC's memory or hard disk. If you'll use your PC for gaming, video-editing or other demanding tasks, you'll need 8GB of RAM and a large hard disk – 1TB should suffice. Many new PCs come with SSDs, which make your PC boot and load programs incredibly quickly.

**05** Having plenty of USB ports is always useful, as most PC peripherals attach to these. Most new PCs come with USB3 ports, which provide faster data transfers when used with supported devices.

**06** Most new PCs come with Windows 10 installed. Don't be too easily swayed by the inclusion of other software. It may be that you'll never use it.

**07** While most PCs come in cases of a similar size, some have more compact mini tower or mini-PC cases. These smaller PCs will fit under your TV or on your desk more easily, but bear in mind that they're significantly harder to upgrade than full-size machines.

### PCs



#### DELL Inspiron Micro Desktop

★★★★★

£179 inc VAT • [www.dell.co.uk](http://www.dell.co.uk)

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#### ACER Revo One RL85

★★★★★

£350 inc VAT • [www.pcworld.co.uk](http://www.pcworld.co.uk)

One of the cleverest PC designs we've seen, the tiny Acer Revo One can house three high-capacity hard disks, making it a perfect living-room PC. With an Intel Core i3 processor, it's no slouch either, and the price is as attractive as the chassis.

PROCESSOR Dual-core 1.7GHz Intel Core i3-4005U • RAM 4GB • FRONT USB PORTS 0 • REAR USB PORTS 2x USB2, 2x USB3 • TOTAL STORAGE 2TB hard disk • GRAPHICS CARD Integrated Intel HD 4000 graphics • DISPLAY None • OPERATING SYSTEM Windows 10 • WARRANTY One year RTB • DETAILS [www.acer.co.uk](http://www.acer.co.uk) • PART CODE DT.SZMEK.014 • FULL REVIEW Aug 2015



#### SCAN 3XS Z170 Performance GTK6

★★★★★

£1,041 inc VAT • [www.scan.co.uk/3xs](http://www.scan.co.uk/3xs)

Scan's first Intel Skylake-powered PC is an incredibly powerful system that can cope with just about any desktop task, and can handle gaming at 2,560x1,440 thanks to an Nvidia GeForce GTX 970 graphics card. The Z170 motherboard makes it future-proof too, with USB3.1 and an M.2 slot for PCI-Express storage.

PROCESSOR Quad-core 4.6GHz Intel Core i5-6600K (overclocked) • RAM 8GB • FRONT USB PORTS 4x USB3 • REAR USB PORTS 2x USB3.1, 1x USB Type-C, 2x USB2 • TOTAL STORAGE 256GB SSD, 1TB hard disk • GRAPHICS CARD 4GB Nvidia GeForce GTX 970 • DISPLAY None • OPERATING SYSTEM Windows 10 • WARRANTY Three years parts cover: first year onsite, years two and three RTB • DETAILS [www.scan.co.uk/3xs](http://www.scan.co.uk/3xs) • PART CODE Performance Z170 GTK6 • FULL REVIEW Nov 2015



### LAPTOPS



#### ASUS ZenBook UX305

★★★★★

£592 inc VAT • [www.nigelohara.com](http://www.nigelohara.com)

The UX305 is the first Asus laptop to run Intel's new low-power Core M processors. Weighing just 1.2kg and 12mm thick, it's one of the thinnest and lightest laptops we've ever tested. Its performance won't set the world alight, but if you're after a portable work machine, look no further.

PROCESSOR Dual-core 800MHz Intel Core M-5Y10C • RAM 8GB • DIMENSIONS 324x226x12mm • WEIGHT 1.2kg • SCREEN SIZE 13.3in • SCREEN RESOLUTION 1,920x1,080 • GRAPHICS ADAPTOR Intel HD 5300 • TOTAL STORAGE 128GB SSD • OPERATING SYSTEM Windows 8.1 • PARTS AND LABOUR WARRANTY One year collect and return • DETAILS [www.asus.com](http://www.asus.com) • PART CODE UX305FA(MS)-FC061H • FULL REVIEW Jun 2015



#### TOSHIBA Satellite Radius 15

★★★★☆

£700 inc VAT • [www.pcworld.co.uk](http://www.pcworld.co.uk)

The Satellite Radius 15 is more expensive than many of its convertible rivals, but its price is justified by its high-quality screen, great battery life and stylish chassis. It's a great way to take advantage of Windows 10's touchscreen elements, too.

PROCESSOR Dual-core 2.2GHz Intel Core i5-5200U • RAM 8GB • DIMENSIONS 380x245x20mm • WEIGHT 2.3kg • SCREEN SIZE 15.6in • SCREEN RESOLUTION 1,920x1,080 • GRAPHICS ADAPTOR Intel HD Graphics 5500 • TOTAL STORAGE 1TB hard disk • OPERATING SYSTEM Windows 8.1 (free Windows 10 upgrade) • WARRANTY One year RTB • DETAILS [www.toshiba.co.uk](http://www.toshiba.co.uk) • PART NUMBER P50W-C10E • FULL REVIEW Dec 2015



#### TOSHIBA Chromebook 2 (CB30-B-104)

★★★★☆

£270 inc VAT • [www.johnlewis.com](http://www.johnlewis.com)

Toshiba's Chromebook 2 is the first budget Chromebook on sale in the UK with a Full HD screen. This increases the price a little but we think it's absolutely worth it. With so much extra space, you can fit more items on the screen and get more done. The machine is lighter and has better battery life than its predecessor, too, making it our current favourite Chromebook.

PROCESSOR Dual-core 2.16GHz Intel Celeron N2840 • RAM 4GB • DIMENSIONS 320x214x19mm • WEIGHT 1.35kg • SCREEN SIZE 13.3in • SCREEN RESOLUTION 1,920x1,080 • GRAPHICS ADAPTOR Intel HD Graphics • TOTAL STORAGE 16GB SSD • OPERATING SYSTEM Google Chrome OS • PARTS AND LABOUR WARRANTY One year RTB • DETAILS [www.toshiba.co.uk](http://www.toshiba.co.uk) • PART CODE PLMOZE-00D003EN • FULL REVIEW May 2015





## SMARTPHONES



### SAMSUNG Galaxy S6

RECOMMENDED ★★★★★

SMARTPHONE

£415 SIM-free, Free on £32-per-month contract • [www.ebuyer.co.uk](http://www.ebuyer.co.uk) (SIM-free), [www.carphonewarehouse.com](http://www.carphonewarehouse.com) (contract)

The all-metal Galaxy S6 is one of Samsung's best phones yet. Its performance is among the best we've seen and its 2,560x1,440 screen looks gorgeous. If you want a phone that will really turn heads, though, there's also the curvy Galaxy S6 Edge.

PROCESSOR Quad-core 2.1GHz & quad-core 1.5GHz Samsung Exynos 7420 • SCREEN SIZE 5.1in • SCREEN RESOLUTION 2,560x1,440 • REAR CAMERA 16 megapixels • STORAGE 32GB • WIRELESS DATA 4G • DIMENSIONS 143x70x6.8mm • WEIGHT 132g • OPERATING SYSTEM Android 5.0 • WARRANTY One year RTB • DETAILS [www.samsung.com/uk](http://www.samsung.com/uk) • PART CODE SM-G920F • FULL REVIEW Jul 2015



### APPLE iPhone 6

BEST BUY ★★★★★

SMARTPHONE

£459 (SIM-free), Free on £32-per-month contract • [www.apple.com/uk](http://www.apple.com/uk) (SIM-free), [www.carphonewarehouse.com](http://www.carphonewarehouse.com) (contract)

A larger screen, faster processor and improved battery life make the iPhone 6 a huge improvement over the iPhone 5s, and it's now even cheaper as Apple makes way for the new iPhone 6s.

PROCESSOR Dual-core 1.4GHz Apple A8 • SCREEN SIZE 4.7in • SCREEN RESOLUTION 1,334x750 • REAR CAMERA 8 megapixels • STORAGE 16GB • WIRELESS DATA 4G • DIMENSIONS 138x67x6.9mm • WEIGHT 129g • OPERATING SYSTEM iOS 9 • WARRANTY One year RTB • DETAILS [www.apple.com/uk](http://www.apple.com/uk) • PART CODE iPhone 6 • FULL REVIEW Dec 2014



### SONY Xperia Z3 Compact

BEST BUY ★★★★★

SMARTPHONE

£312 (SIM-free), Free on £18.50-per-month contract • [www.handtec.co.uk](http://www.handtec.co.uk) (SIM-free), [www.carphonewarehouse.com](http://www.carphonewarehouse.com) (contract)

With its incredible 20-hour battery life and fast performance, the Sony Xperia Z3 Compact brings flagship features to a smaller handset at a great price.

PROCESSOR Quad-core 2.5GHz Qualcomm Snapdragon 801 • SCREEN SIZE 4.6in • SCREEN RESOLUTION 1,280x720 • REAR CAMERA 20.7 megapixels • STORAGE 16GB • WIRELESS DATA 4G • DIMENSIONS 127x65x8.6mm • WEIGHT 129g • OPERATING SYSTEM Android 4.4 • DETAILS [www.sony.co.uk](http://www.sony.co.uk) • PART CODE Sony D5803 • FULL REVIEW Jan 2015



### MICROSOFT Lumia 640

BEST BUY ★★★★★

SMARTPHONE

£120 (SIM-free), £20 on £9.50-per-month contract • [www.argos.co.uk](http://www.argos.co.uk) (SIM-free), [www.idmobile.co.uk](http://www.idmobile.co.uk) (contract)

The best budget Windows phone around. Its 5in screen is fantastic and its snappy performance punches above its price range. There's also the jumbo Lumia 640 XL if you want a longer battery life.

PROCESSOR Quad-core 1.2GHz Qualcomm Snapdragon 400 • SCREEN SIZE 5in • SCREEN RESOLUTION 1,280x720 • REAR CAMERA 8 megapixels • STORAGE 8GB • WIRELESS DATA 4G • DIMENSIONS 141x72x8.8mm • WEIGHT 145g • OPERATING SYSTEM Windows Phone 8.1 • DETAILS [www.microsoft.com](http://www.microsoft.com) • PART CODE RM-1072 • FULL REVIEW Aug 2015



### VODAFONE Smart Ultra 6

BEST BUY ★★★★★

SMARTPHONE

£125 (Pre-pay), Free on £17-per-month contract • [www.vodafone.co.uk](http://www.vodafone.co.uk) (Pre-pay and contract)

The Vodafone Smart Ultra 6 is a mid-range smartphone at an entry-level price. Packed with an octa-core processor, a huge Full HD display and a great camera, the Smart Ultra 6 is unbelievably good value.

PROCESSOR Octa-core 1.7GHz Qualcomm Snapdragon 615 • SCREEN SIZE 5.5in • SCREEN RESOLUTION 1,920x1,080 • REAR CAMERA 13 megapixels • STORAGE 16GB • WIRELESS DATA 4G • DIMENSIONS 154x77x8.4mm • WEIGHT 159g • OPERATING SYSTEM Android 5.0.2 • WARRANTY One year RTB • DETAILS [www.vodafone.co.uk](http://www.vodafone.co.uk) • PART CODE Smart Ultra 6 • FULL REVIEW Nov 2015



## TABLETS



### SONY Xperia Z4 Tablet

RECOMMENDED ★★★★★

TABLET

£499 inc VAT • [www.johnlewis.com](http://www.johnlewis.com)

It's expensive, but the Z4 Tablet is a stunning bit of kit. It weighs just 389g, so is lighter than the iPad Air 2, and is an amazing 6.1mm thick. Its super-high-resolution screen has most accurate colours we've seen from an LCD panel, it runs Android 5 beautifully and has the longest battery life of any tablet we've tested.

PROCESSOR Octa-core 2GHz Qualcomm Snapdragon 810 • SCREEN SIZE 10.1in • SCREEN RESOLUTION 2,560x1,600 • REAR CAMERA 8.1 megapixels • STORAGE 32GB • WIRELESS DATA 4G (optional) • DIMENSIONS 167x254x6.1mm • WEIGHT 389g • OPERATING SYSTEM Android 5 • WARRANTY One year RTB • DETAILS [www.sonymobile.com](http://www.sonymobile.com) • PART CODE Xperia Z4 Tablet • FULL REVIEW Aug 2015



### GOOGLE Nexus 9

BEST BUY ★★★★★

TABLET

£200 inc VAT • [www.argos.co.uk](http://www.argos.co.uk)

The Nexus 9 is the first Google-branded tablet to have an iPad-style 4:3 ratio screen, which we think is a better shape for web browsing. Android 5.0 Lollipop runs beautifully and its battery life is superb.

PROCESSOR Dual-core 2.3GHz 64-bit Nvidia Tegra K1 Denver • SCREEN SIZE 8.9in • SCREEN RESOLUTION 2,048x1,536 • REAR CAMERA 8 megapixels • STORAGE 16GB • WIRELESS DATA 4G (optional) • DIMENSIONS 154x228x8.6mm • WEIGHT 425g • OPERATING SYSTEM Android 5.0 • WARRANTY One year RTB • PART CODE Nexus 9 • DETAILS [www.google.com/nexus/9](http://www.google.com/nexus/9) • FULL REVIEW Aug 2015



### APPLE iPad Air 2

RECOMMENDED ★★★★★

TABLET

£399 inc VAT • [www.apple.com/uk](http://www.apple.com/uk)

The iPad Air 2 is even thinner and lighter than its predecessor and still feels beautifully made. It's the fastest iPad yet, and now has TouchID fingerprint recognition for added security.

PROCESSOR Tri-core 1.5GHz Apple A8X • SCREEN SIZE 9.7in • SCREEN RESOLUTION 2,048x1,536 • REAR CAMERA 8 megapixels • STORAGE 16GB • WIRELESS DATA 4G (optional) • DIMENSIONS 240x170x6.1mm • WEIGHT 437g • OPERATING SYSTEM iOS 9 • WARRANTY One year RTB • PART CODE Apple iPad Air 2 • DETAILS [www.apple.com/uk](http://www.apple.com/uk) • FULL REVIEW Aug 2015



### MICROSOFT Surface 3

RECOMMENDED ★★★★★

TABLET

£499 inc VAT • [www.microsoftstore.com](http://www.microsoftstore.com)

If you're after a Windows tablet but the £600-plus Surface Pro 3 is too much for you, the Surface 3 is the model to get. It's beautifully made with a great screen, and if you add the optional Type Cover keyboard you'll have a super-light laptop for working on the move.

PROCESSOR Quad-core 1.6GHz Intel Atom X7-28700 • SCREEN SIZE 10.8in • SCREEN RESOLUTION 1,920x1,280 • REAR CAMERA 8 megapixels • STORAGE 128GB • WIRELESS DATA 4G (coming soon) • DIMENSIONS 187x267x8.7mm • WEIGHT 622g • OPERATING SYSTEM Windows 10 • WARRANTY One year RTB • DETAILS [www.microsoft.com](http://www.microsoft.com) • PART CODE Surface 3 • FULL REVIEW Aug 2015



### SAMSUNG Galaxy Tab S2 9.7

RECOMMENDED ★★★★★

TABLET

£400 inc VAT • [www.johnlewis.com](http://www.johnlewis.com)

Thanks to its amazing screen, strong performance and slimline chassis, the Galaxy Tab S2 9.7 is the most desirable Android tablet you can buy for under £500

PROCESSOR Octa-core 1.9GHz Samsung Exynos Octa 5433 • SCREEN SIZE 9.7in • SCREEN RESOLUTION 2,048x1,536 • REAR CAMERA 8 megapixels • STORAGE 32GB • WIRELESS DATA 4G + £90 • DIMENSIONS 169x237x5.6mm • WEIGHT 389g • OPERATING SYSTEM Android 5.0.2 • WARRANTY One year RTB • PART CODE SM-T810 • DETAILS [www.samsung.com](http://www.samsung.com) • FULL REVIEW December 2015



## Choosing a...

### Tablet

**01** All tablets rely on an operating system (OS) to run apps. You have three main choices: Apple's iOS, which runs on the iPad Air and iPad Mini, Android, which Google licenses to various manufacturers, and Windows 10, which is slowly becoming more common in hybrid tablets and convertibles.

If you own an Apple or Google smartphone, you can download your apps, music and so on to a tablet that runs the same OS, so it makes sense to stick with a compatible device.

**02** It's important to pick a tablet that has a good-quality high-resolution screen. Many budget tablets have 1,280x800-resolution displays, but better tablets have Full HD 1,920x1,080 panels, and we're starting to see tablets that have even higher screen resolutions. Some are as high as 2,560x1,600 or even 4K.

Entry-level tablets typically use TN panels, which don't have particularly good viewing angles. The viewing angles of IPS panels are much better.

**03** If you want to listen to music, watch films and play games, make sure your tablet has plenty of storage. Many tablets come with 8GB or 16GB of internal storage as standard, although some budget models have less. You'll typically pay more for a higher storage capacity. Many tablets also have microSD slots that let you add extra storage, although you won't find one on an iPad. MicroSD cards are a cheap way of boosting storage capacity.

**04** Tablets rarely include a SIM card slot. This means you'll have to rely on Wi-Fi to get online, although some tablets let you access the internet through your smartphone. If you want mobile access to the internet, look for 3G- and 4G-ready devices. These almost always cost more than Wi-Fi-only models but they're great if you use your tablet while commuting or travelling.

**05** Your choice of tablet determines the apps you can use on it. You may find that some of the apps you want are available on iOS but not Android and vice versa. Windows 10, meanwhile, runs traditional desktop applications.

# Choosing a...

## Monitor

**01** A basic 24in LCD monitor costs around £100. It will be fine for typical Windows work but is likely to have poor viewing angles, so you'll need to view it head on to achieve the best picture quality. Its colour accuracy may not be very good, either.

**02** A VGA input lets you use the monitor with any PC, but the quality may not be as good as it is over DVI or HDMI. Both are digital connections and require a compatible graphics card but they avoid the need for digital-to-analogue or analogue-to-digital conversions, which can reduce image quality. A digital connection achieves the best picture automatically, so you won't have to adjust clock or phase settings as you do with analogue connections.

Many DVI and all HDMI and DisplayPort connections support HDCP, which lets you watch protected video content, such as Blu-ray movies. DisplayPort is becoming popular, but you'll need a graphics card with a DisplayPort output (mini or full-size) to use this input on your monitor.

**03** A larger monitor will be easier on the eye and may have a higher resolution. Most monitors have resolutions of at least 1,920x1,080 (1080p), which provides lots of room for working with multiple windows at the same time. For even higher resolutions, you'll need a larger display. Some 27in and 30in screens have 2,560x1,600 or even 4K resolutions. You'll need a graphics card with a dual-link DVI output and a dual-link DVI cable or either HDMI or DisplayPort to use a monitor at these resolutions.

**04** If you want better picture quality, look for a monitor with a high contrast ratio. The higher the ratio, the whiter the whites and the blacker the blacks. You'll also be able to see more fine detail in images with high contrast levels. Viewing angles are important, as wider angles mean you don't have to sit directly in front of the monitor to get the best picture. Wider viewing angles also allow more people to view the screen at the same time.

Fast response times reduce ghosting, but don't be dazzled by the numbers. A response time of 25ms or quicker is fine for all applications.

## PHOTOGRAPHY

COMPACT SYSTEM CAMERA	<p><b>COMPUTER SHOPPER BEST BUY</b> ★★★★★</p> <p><b>PANASONIC</b> Lumix DMC-G7</p> <p>£549 inc VAT (with 14-42mm kit lens) • <a href="http://www.jessops.com">www.jessops.com</a></p> <p>With sophisticated autofocus, superb controls and 4K video capture, the Panasonic G7 packs a serious punch for both video and stills photography.</p> <p>SENSOR RESOLUTION 16 megapixels • SENSOR SIZE 17.3x13mm • FOCAL LENGTH MULTIPLIER 2x • VIEWFINDER Electronic (2,360,000 dots) • LCD SCREEN 3in (1,040,000 dots) • OPTICAL ZOOM (35mm-EQUIVALENT FOCAL LENGTHS) 5x (28-84mm) • 35mm-EQUIVALENT APERTURE f/1.7-1.2 • LENS MOUNT Micro Four Thirds • WEIGHT 525g • DIMENSIONS 87x135x108mm • WARRANTY One year RTB • DETAILS <a href="http://www.panasonic.com/uk">www.panasonic.com/uk</a> • FULL REVIEW Nov 2015</p>	
COMPACT CAMERA	<p><b>COMPUTER SHOPPER BEST BUY</b> ★★★★★</p> <p><b>NIKON</b> Coolpix S9700</p> <p>£150 inc VAT • <a href="http://www.buyacamera.co.uk">www.buyacamera.co.uk</a></p> <p>This compact camera packs in a 30x zoom lens, Wi-Fi, GPS and slow-motion video. Its has a comprehensive set of controls, but it's the image quality that really impresses, achieving decent shots in tough conditions.</p> <p>SENSOR RESOLUTION 16 megapixels • SENSOR SIZE 1/2.3in • VIEWFINDER None • LCD SCREEN 3in (921,000 dots) • OPTICAL ZOOM (35mm-EQUIVALENT FOCAL LENGTHS) 30x (25-750mm) • 35mm-EQUIVALENT APERTURE f/21-3.6 • WEIGHT 235g • DIMENSIONS 66x110x34mm • WARRANTY Two years RTB • DETAILS <a href="http://www.nikon.co.uk">www.nikon.co.uk</a> • FULL REVIEW Nov 2014</p>	
ULTRA-ZOOM CAMERA	<p><b>COMPUTER SHOPPER BEST BUY</b> ★★★★★</p> <p><b>PANASONIC</b> Lumix DMC-FZ200</p> <p>£298 inc VAT • <a href="http://www.johnlewis.com">www.johnlewis.com</a></p> <p>This ultra-zoom camera has a big 25-600mm zoom range and maintains a fast F2.8 aperture across the whole focal range, so you can shoot in low-light conditions without too much worry.</p> <p>SENSOR RESOLUTION 12.1 megapixels • SENSOR SIZE 6.2x4.6mm (1/2.3in) • VIEWFINDER Electronic • LCD SCREEN 3in • OPTICAL ZOOM (35mm-EQUIVALENT FOCAL LENGTHS) 24x (25-600mm) • 35mm-EQUIVALENT APERTURE f/15.5-9 • WEIGHT 588g • DIMENSIONS 87x125x110mm • WARRANTY One year RTB • DETAILS <a href="http://www.panasonic.com/uk">www.panasonic.com/uk</a> • FULL REVIEW Feb 2013</p>	
CONSUMER SLR	<p><b>COMPUTER SHOPPER BEST BUY</b> ★★★★★</p> <p><b>CANON</b> EOS 750D</p> <p>£562 inc VAT (with 18-55mm kit lens) • <a href="http://www.jessops.com">www.jessops.com</a></p> <p>The 750D is the new mainstay of Canon's SLR line-up. Better autofocus, D5500-beating image quality and decent video too: this is the mid-range SLR to buy. Also comes with extra manual controls as the 760D.</p> <p>SENSOR RESOLUTION 24 megapixels • SENSOR SIZE 22.3x14.9mm (APS-C) • FOCAL LENGTH MULTIPLIER 1.6x • VIEWFINDER Optical • LCD SCREEN 3in • OPTICAL ZOOM (35mm-EQUIVALENT FOCAL LENGTHS) 5x (29-88mm) • 35mm-EQUIVALENT APERTURE f/5.6-9 • LENS MOUNT Canon EF-S • WEIGHT 771g • DIMENSIONS 104x132x148mm • WARRANTY One year RTB • DETAILS <a href="http://www.canon.co.uk">www.canon.co.uk</a> • FULL REVIEW Oct 2015</p>	
COMPACT CAMERA	<p><b>COMPUTER SHOPPER BEST BUY</b> ★★★★★</p> <p><b>CANON</b> PowerShot G7 X</p> <p>£379 inc VAT • <a href="http://www.wexphotographic.com">www.wexphotographic.com</a></p> <p>With near SLR-quality stills in a truly pocketable package, the PowerShot G7 X is a huge step up from most other compact cameras - and at an excellent price.</p> <p>SENSOR RESOLUTION 20 megapixels • SENSOR SIZE 1in • VIEWFINDER None • LCD SCREEN 3in (1,040,000 dots) • OPTICAL ZOOM (35mm-EQUIVALENT FOCAL LENGTHS) 4.2x (24-100mm) • 35mm-EQUIVALENT APERTURE f/4.9-7.6 • WEIGHT 301g • DIMENSIONS 64x107x40mm • WARRANTY One year RTB • DETAILS <a href="http://www.canon.co.uk">www.canon.co.uk</a> • FULL REVIEW May 2015</p>	

## DISPLAYS

MONITOR	<p><b>COMPUTER SHOPPER BEST BUY</b> ★★★★★</p> <p><b>BENQ</b> GW2765HT</p> <p>£284 inc VAT • <a href="http://www.laptopsdirect.co.uk">www.laptopsdirect.co.uk</a></p> <p>This 27in 2,560x1,440 IPS monitor is one of the best-value screens we've ever seen. With near-perfect sRGB colour accuracy out of the box, it's a steal for less than £300.</p> <p>SCREEN SIZE 27in • RESOLUTION 2,560x1,440 • SCREEN TECHNOLOGY IPS • VIDEO INPUTS VGA, DVI, HDMI, DisplayPort • WARRANTY Two years onsite • PART CODE GW2765HT • DETAILS <a href="http://www.benq.co.uk">www.benq.co.uk</a> • FULL REVIEW Jan 2015</p>	
MONITOR	<p><b>COMPUTER SHOPPER RECOMMENDED</b> ★★★★★☆</p> <p><b>VIEWSONIC</b> VX2363Smhl-W</p> <p>£129 inc VAT • <a href="http://www.dabs.com">www.dabs.com</a></p> <p>The 23in VX2363Smhl-W stands out from the crowd with its white stand, IPS screen and great overall image quality. It's a good budget buy for those who have modest needs.</p> <p>SCREEN SIZE 23in • RESOLUTION 1,920x1,080 • SCREEN TECHNOLOGY IPS • VIDEO INPUTS VGA, 1x HDMI, 1x MHL-compatible HDMI • WARRANTY Two years collect and return • PART CODE VX2363Smhl-W • DETAILS <a href="http://www.viewsoniceurope.com">www.viewsoniceurope.com</a> • FULL REVIEW Jan 2015</p>	
MONITOR	<p><b>COMPUTER SHOPPER BEST BUY</b> ★★★★★</p> <p><b>IYAMA</b> ProLite GB2488HSU-B1</p> <p>£200 inc VAT • <a href="http://www.box.co.uk">www.box.co.uk</a></p> <p>Gamers need look no further than the Iiyama ProLite GB2488HSU-B1. It's a no-nonsense Full HD panel with a 144Hz refresh rate for lightning-fast games.</p> <p>SCREEN SIZE 24in • RESOLUTION 1,920x1,080 • SCREEN TECHNOLOGY TN • VIDEO INPUTS 2x HDMI, DVI, DisplayPort • WARRANTY Two years onsite • PART CODE ProLite GB2488HSU-B1 • DETAILS <a href="http://www.iiyama.com">www.iiyama.com</a> • FULL REVIEW Aug 2014</p>	
MONITOR	<p><b>COMPUTER SHOPPER BEST BUY</b> ★★★★★</p> <p><b>ASUS</b> PB279Q</p> <p>£575 inc VAT • <a href="http://www.debenhamsplus.com">www.debenhamsplus.com</a></p> <p>If you're remotely serious about design, photography or gaming and want an Ultra HD screen, this is the monitor to choose. It's plain to look at and has no USB hub, but in terms of pure image quality, nothing beats it at this price.</p> <p>SCREEN SIZE 27in • RESOLUTION 3,840x2,160 • SCREEN TECHNOLOGY AHVA • REFRESH RATE 60Hz • VIDEO INPUTS 4x HDMI, DisplayPort, Mini DisplayPort • WARRANTY Three years RTB • DETAILS <a href="http://www.asus.com">www.asus.com</a> • FULL REVIEW Apr 2015</p>	
MONITOR	<p><b>COMPUTER SHOPPER BEST BUY</b> ★★★★★</p> <p><b>SAMSUNG</b> S32D850T</p> <p>£410 inc VAT • <a href="http://www.laptopsdirect.co.uk">www.laptopsdirect.co.uk</a></p> <p>It's not cheap, but this 32in monitor is great value. Images are sharp and vibrant on its 2,560x1,440 panel, and the stand is among the most attractive we've seen.</p> <p>SCREEN SIZE 32in • RESOLUTION 2,560x1,440 • SCREEN TECHNOLOGY VA • VIDEO INPUTS HDMI, DVI, DisplayPort • WARRANTY Two years collect and return • PART CODE S32D850T • DETAILS <a href="http://www.samsung.com/uk">www.samsung.com/uk</a> • FULL REVIEW Jan 2015</p>	

## Soundbar

**01** If you simply don't have room in your home cinema setup for a set of surround sound speakers, a soundbar is the next best thing. Whether you opt for a soundbar – which typically sits in front of your TV stand – or a soundplate, which you place under your TV, you'll enjoy significantly better audio than the weedy speakers in today's flatscreen TVs can provide.

**02** If you want to cut down on cable clutter, look for a soundbar with multiple HDMI inputs and outputs as well as Audio Return Channel (ARC). Not all soundbars use HDMI, as many make do with digital optical audio connections instead. This means you'll have to connect Blu-ray players, games consoles and set-top boxes to your TV and run all audio through a single cable. Also look for phono inputs for connecting older devices, and 3.5mm audio jacks for tablets or smartphones.

**03** As with any speaker, the number of speaker drivers inside a soundbar should give you a good indication of its audio capabilities. Although this won't tell you everything about the sound quality, you should still look out for separate mid-range drivers and tweeters, as these should be able to deliver a wider frequency range than full-range drivers alone.

**04** Bluetooth support is a must if you want to listen to music from a smartphone or tablet without wires. Most soundbars now include Bluetooth as standard, but if your device supports aptX it's worth looking for a model that includes it. This codec is less lossy and capable of higher quality streaming than the standard A2DP profile. Airplay streaming is less common, but iPhone owners should keep an eye out for it.

**05** For a little extra bass, be sure to look for a soundbar that has a subwoofer. Many include a wired sub, but for extra convenience you should look for a model that has a wireless subwoofer instead. These can be placed anywhere in a room that's within reach of a power socket, as you don't have to run a cable back to the soundbar itself.

### HOME CINEMA

**COMPUTER SHOPPER** **PHILIPS** 55PFT6510/12  
RECOMMENDED ★★★★★

£800 inc VAT • [www.argos.co.uk](http://www.argos.co.uk)

This Full HD TV uses the rapidly improving Android TV operating system. Its default image quality settings aren't great, but after tweaking this TV rewards you handsomely.

SCREEN SIZE 55in • NATIVE RESOLUTION 1,920x1,080 • VIDEO INPUTS 4x HDMI, SCART, Component • TUNER Freeview HD • DIMENSIONS 726x1,239x279mm • WARRANTY Two years RTB • DETAILS [www.philips.co.uk](http://www.philips.co.uk) • PART CODE 55PFT6510/12 • FULL REVIEW Dec 2015



SMART TV

**COMPUTER SHOPPER** **SAMSUNG** J6300  
RECOMMENDED ★★★★★

£349 inc VAT • [www.a0.com](http://www.a0.com)

It might look expensive for the screen size, but the J6300 is jam-packed with features, including one of the best smart TV systems around and every major UK catch-up TV service. It's the ideal small TV for a bedroom, kitchen or office.

SCREEN SIZE 32in • NATIVE RESOLUTION 1,920x1,080 • VIDEO INPUTS 4x HDMI, component, composite • TUNER Freeview HD • DIMENSIONS 428x370x91mm • WARRANTY One year RTB • DETAILS [www.samsung.com/uk](http://www.samsung.com/uk) • PART CODE UE32J6300AK • FULL REVIEW Dec 2015



SMART TV

**COMPUTER SHOPPER** **SAMSUNG** BD-J7500  
RECOMMENDED ★★★★★

£123 inc VAT • [www.morecomputers.com](http://www.morecomputers.com)

4K upscaling, fantastic image quality and a wealth of streaming service support makes the BD-J7500 so much more than just a Blu-ray player.

BLU-RAY PROFILE 5.0 • 3D CAPABLE Yes • DIMENSIONS 360x224x39mm • NETWORKING Ethernet, 802.11ac, Wi-Fi • WARRANTY One year RTB • DETAILS [www.samsung.com/uk](http://www.samsung.com/uk) • PART CODE BD-J7500 • FULL REVIEW Nov 2015



BLU-RAY PLAYER

**COMPUTER SHOPPER** **LG** LHB725  
RECOMMENDED ★★★★★

£348 inc VAT • [www.a0.com](http://www.a0.com)

A 3D-capable home cinema surround system with a Blu-ray player that has fantastic image quality and speakers that deliver powerful sound, all housed in an attractive package.

HDMI INPUTS/OUTPUTS 2/1 • HDMI 2.0 INPUTS/OUTPUTS 2/1 • OUTPUT RESOLUTIONS 720p, 1080p • WIRELESS SUPPORT 802.11n, Bluetooth • SPEAKER CONFIGURATION 5.1 • RMS POWER OUTPUT TOTAL 1,200W • DIMENSIONS 410x55x260mm • WARRANTY One year RTB • DETAILS [www.lg.com/uk](http://www.lg.com/uk) • PART CODE LHB725 • FULL REVIEW Oct 2015



HOME CINEMA SYSTEM

**COMPUTER SHOPPER** **SAMSUNG** HW-J7500  
RECOMMENDED ★★★★★

£429 inc VAT • [www.applianceelectronics.co.uk](http://www.applianceelectronics.co.uk)

This curved 8.1 soundbar and wireless subwoofer not only looks great, but it also produces excellent sound and has plenty of ports.

SPEAKERS 8 • RMS POWER OUTPUT 320W • DOCK CONNECTOR None • NETWORKING Bluetooth 3.0 • DIMENSIONS 1,230x170x42mm (soundbar), 291x371x291mm (subwoofer) • WEIGHT 4kg (soundbar), 7.8kg (subwoofer) • WARRANTY One year RTB • DETAILS [www.samsung.com/uk](http://www.samsung.com/uk) • PART CODE HW-J7500 • FULL REVIEW Jul 2015



SOUNDBAR/SUBWOOFER

### AUDIO

**COMPUTER SHOPPER** **PHILIPS** Fidelio M2BT  
BEST BUY ★★★★★

£165 inc VAT • [www.amazon.co.uk](http://www.amazon.co.uk)

The Philips Fidelio M2BT are premium Bluetooth headphones that sound great, look fantastic and are supremely comfortable.

HEADPHONES TYPE On-ear Bluetooth • PLUG TYPE 3.5mm jack plug • WEIGHT 190g • CABLE LENGTH 1.2m • WARRANTY One year RTB • DETAILS [www.philips.co.uk](http://www.philips.co.uk) • PART CODE M2BTBK/00 • FULL REVIEW Apr 2015



ON-EAR HEADPHONES

**COMPUTER SHOPPER** **RAUMFELD** One S  
RECOMMENDED ★★★★★

£200 inc VAT • [www.raumfeld.com/uk](http://www.raumfeld.com/uk)

The One S is an excellent compact speaker that sounds great on its own or even better as a stereo pair, and has a classy design that matches its refined sound.

SPEAKERS 4 • RMS POWER OUTPUT 30W • DOCK CONNECTOR None • NETWORKING 802.11n Wi-Fi • DIMENSIONS 180x110x130mm • WEIGHT 1.4kg • STREAMING FORMATS UPnP, Mesh Network • WARRANTY One year RTB • DETAILS [www.raumfeld.com/uk](http://www.raumfeld.com/uk) • PART CODE One S • FULL REVIEW Nov 2015



MULTIROOM SPEAKER

**COMPUTER SHOPPER** **RAZER** Leviathan  
RECOMMENDED ★★★★★

£150 inc VAT • [www.box.co.uk](http://www.box.co.uk)

Soundbars are usually built for TVs, but Razer's Leviathan is ideal for sliding under a computer monitor. It sounds great and is more than loud enough to fill a room.

SPEAKERS 4 • RMS POWER OUTPUT 30W • WEIGHT 2kg (bar), 2.3kg (subwoofer) • NETWORKING Bluetooth (SBC, aptX) • WARRANTY Two years RTB • DETAILS [www.razerzone.com](http://www.razerzone.com) • PART CODE RZ05-01260100-R3G1 • FULL REVIEW Jul 2015



PC GAMING SOUNDBAR

**COMPUTER SHOPPER** **LOGITECH** UE Megaboom  
RECOMMENDED ★★★★★

£237 inc VAT • [www.ballinc.com](http://www.ballinc.com)

The UE Megaboom is an intensely loud and powerful Bluetooth speaker that provides a warm and impactful sound. It's waterproof, too, so could provide some entertainment poolside or at your next barbecue.

SPEAKERS 4 • RMS POWER OUTPUT Not disclosed • DOCK CONNECTOR None • WIRELESS Bluetooth (SBC) • DIMENSIONS 83x83x226mm • WEIGHT 877g • WARRANTY Two years RTB • DETAILS [www.ultimateears.com](http://www.ultimateears.com) • PART CODE 984-000438 • FULL REVIEW Aug 2015



BLUETOOTH SPEAKER

**COMPUTER SHOPPER** **ARCAM** miniBlink  
RECOMMENDED ★★★★★

£100 inc VAT • [www.petertyson.co.uk](http://www.petertyson.co.uk)

Stream music from your mobile phone or tablet to your hi-fi with the petite and attractive miniBlink. This high-quality Bluetooth receiver sounds good and is delightfully simple to use.

WARRANTY Two years RTB • PART CODE miniBlink • DETAILS [www.arcam.co.uk](http://www.arcam.co.uk) • FULL REVIEW Aug 2014



AUDIO INTERFACE

# Choosing an ...

## Inkjet printer

**01** You should be able to buy a decent inkjet printer for less than £40. High-quality printing is possible on such a printer, but it will be slow.

The actual print speed of an inkjet can be half the quoted (maximum) speed for text documents, and even slower when printing graphics. Budget inkjet printers such as these are designed only for light use and can be expensive to run.

**02** For £60 you can buy a much more capable printer that's either faster and better built or better at reproducing photos. If documents are your priority, you'll want a high minimum speed and low print costs. Look for inkjets that can handle all your office media, such as envelopes and labels.

**03** If photos are your priority, speed is less important. Choose a printer that reproduces subtle tones well. You can't determine this by looking at the specifications – only hands-on testing will do, so remember to check our reviews before you buy. Borderless printing (up to the edge of the paper) should also be possible.

Pay particular attention to running costs: photos use three times as much ink as regular colour documents.

**04** Heavy-duty office inkjets can cost up to £1,000 and their build quality is improving. They use large individual ink tanks, which can cut running costs. Printers with automatic duplex (double-sided) printing or A3 capabilities are now much more affordable.

**05** Pricier photo printers let you print from memory cards plugged straight into the printer, so you don't need to use a PC. An LCD preview screen offers greater control for this method of printing. Many inkjet printers now have a PictBridge USB port, which you can use to print images directly from most digital cameras.

**06** If you're really serious about photography, consider buying an inkjet that can produce borderless prints up to A3 size. The best devices can print photos that look nearly as good as those from professional labs.

## STORAGE

SSD	<p><b>COMPUTER SHOPPER</b> RECOMMENDED ★★★★★</p> <p><b>SAMSUNG</b> 850 Evo 500GB</p> <p>£135 inc VAT • <a href="http://www.scan.co.uk">www.scan.co.uk</a></p> <p>Samsung's 850 Evo is simply the fastest SATA SSD around, and it's available in a wide range of capacities. The 500GB model is fantastic value for money.</p> <p>CAPACITY 500GB • COST PER GIGABYTE £0.27 • INTERFACE SATA3 • CLAIMED READ 540MB/s • CLAIMED WRITE 520MB/s • WARRANTY Five years RTB • DETAILS <a href="http://www.samsung.com/uk">www.samsung.com/uk</a> • PART CODE MZ-75E500BW/EU • FULL REVIEW Oct 2015</p>	
HARD DISK	<p><b>COMPUTER SHOPPER</b> BEST BUY ★★★★★</p> <p><b>WESTERN DIGITAL</b> Red 6TB</p> <p>£190 inc VAT • <a href="http://www.dabs.com">www.dabs.com</a></p> <p>The Red 6TB combines excellent performance with a high capacity and special firmware, making a hard disk that's perfect for use in NAS enclosures.</p> <p>CAPACITY 6TB • COST PER GIGABYTE £0.03 • INTERFACE SATA3 • WARRANTY Three years RTB • PART CODE WD60EFRX • DETAILS <a href="http://www.wdc.com">www.wdc.com</a> • FULL REVIEW Nov 2014</p>	
NAS	<p><b>COMPUTER SHOPPER</b> BEST BUY ★★★★★</p> <p><b>SYNOLOGY</b> Diskstation DS215j</p> <p>£130 inc VAT • <a href="http://www.dabs.com">www.dabs.com</a></p> <p>Synology's latest NAS is faster than its predecessor thanks to an upgraded CPU, and is capable of rapid file transfers. DSM is still the best NAS operating system we've used, too.</p> <p>3.5in HARD DISK BAYS (FREE) 2 (2) • NETWORKING 2x10/100/1,000 Ethernet • WARRANTY Two years RTB • PART CODE DS215J • DETAILS <a href="http://www.synology.com">www.synology.com</a> • FULL REVIEW Jun 2015</p>	
PORTABLE SSD	<p><b>COMPUTER SHOPPER</b> BEST BUY ★★★★★</p> <p><b>SAMSUNG</b> T1 500GB</p> <p>£170 inc VAT • <a href="http://www.pcoworld.co.uk">www.pcoworld.co.uk</a></p> <p>The T1 has its own SSD controller, making it significantly faster than any USB3 flash drive. It's able to transfer files at unbelievable speeds – then slip into a pocket for taking on the move.</p> <p>CAPACITY 500GB • COST PER GIGABYTE £0.33 • INTERFACE USB3 • CLAIMED READ 450MB/s • CLAIMED WRITE 450MB/s • WARRANTY Three years RTB • PART CODE MU-PS500B/EU • DETAILS <a href="http://www.samsung.com/uk">www.samsung.com/uk</a> • FULL REVIEW Apr 2015</p>	
PORTABLE HARD DISK	<p><b>COMPUTER SHOPPER</b> BEST BUY ★★★★★</p> <p><b>TOSHIBA</b> Canvio Connect II 2TB</p> <p>£72 inc VAT • <a href="http://www.dabs.com">www.dabs.com</a></p> <p>An excellent bundled software package and impressive USB3 speeds. Considering the price, there's no reason not to buy one.</p> <p>CAPACITY 2TB • COST PER GIGABYTE £0.04 • INTERFACE USB3 • WARRANTY One year RTB • PART CODE HDTC820ER3CA • DETAILS <a href="http://www.toshiba.eu">www.toshiba.eu</a> • FULL REVIEW Nov 2015</p>	

## PRINTERS AND SCANNERS

MONO LED PRINTER	<p><b>COMPUTER SHOPPER</b> BUSINESS BUY ★★★★★</p> <p><b>RICOH</b> SP 3600DN</p> <p>£165 inc VAT • <a href="http://www.ebuyer.com">www.ebuyer.com</a></p> <p>The SP 3600DN can print up to 50,000 pages per month at 30ppm. The quality is good, and each page costs only about 1.2p. It's a good choice for a busy small firm.</p> <p>TECHNOLOGY Mono LED • MAXIMUM PRINT RESOLUTION 1,200x1,200dpi • DIMENSIONS 268x370x392mm • WEIGHT 14.5kg • MAXIMUM PAPER SIZE A4/legal • WARRANTY Two years RTB • DETAILS <a href="http://www.ricoh.co.uk">www.ricoh.co.uk</a> • PART CODE 906231 • FULL REVIEW Oct 2015</p>	
COLOUR LASER	<p><b>COMPUTER SHOPPER</b> BEST BUY ★★★★★</p> <p><b>CANON</b> i-SENSYS LBP7780Cx</p> <p>£417 inc VAT • <a href="http://www.printerland.co.uk">www.printerland.co.uk</a></p> <p>It's somewhat expensive to buy, but the Canon i-SENSYS LBP7780Cx is very cheap to run and produces impressively high-quality prints.</p> <p>TECHNOLOGY Single-pass colour laser • MAXIMUM PRINT RESOLUTION 600x600dpi • DIMENSIONS 401x517x530mm • WEIGHT 31kg • MAXIMUM PAPER SIZE A4/legal • WARRANTY One year onsite • DETAILS <a href="http://www.canon.co.uk">www.canon.co.uk</a> • PART CODE 6140B010AA • FULL REVIEW Mar 2015</p>	
INKJET MFP	<p><b>COMPUTER SHOPPER</b> BEST BUY ★★★★★</p> <p><b>EPSON</b> Expression Photo XP-760</p> <p>£125 inc VAT • <a href="http://www.box.co.uk">www.box.co.uk</a></p> <p>It's not brilliant for printing office documents, but if you want great photos and fantastic scanning, Epson's good-looking and compact XP-760 is perfect.</p> <p>TECHNOLOGY Piezo inkjet • MAXIMUM PRINT RESOLUTION 5,760x1,440dpi • MAXIMUM OPTICAL SCAN RESOLUTION (OUTPUT BIT DEPTH) 2,400x4,800dpi (48-bit) • DIMENSIONS 141x390x341mm • WEIGHT 6.9kg • MAXIMUM PAPER SIZE A4/legal • WARRANTY One year RTB • DETAILS <a href="http://www.epson.co.uk">www.epson.co.uk</a> • PART CODE C11CD96401 • FULL REVIEW Mar 2015</p>	
INKJET MFP	<p><b>COMPUTER SHOPPER</b> BEST BUY ★★★★★</p> <p><b>CANON</b> Pixma MG6650</p> <p>£75 inc VAT • <a href="http://www.amazon.co.uk">www.amazon.co.uk</a></p> <p>This well-specified MFP isn't the fastest, but its print, copy and scan quality are superb. Improved touchscreen controls make it easier to use than some Pixmas, and its ink costs are reasonable too.</p> <p>TECHNOLOGY Thermal inkjet • MAXIMUM PRINT RESOLUTION 4,800x1,200dpi • SCANNER RESOLUTION 1,200x2,400dpi • DIMENSIONS 148x455x369mm • WEIGHT 6.4kg • MAXIMUM PAPER SIZE A4/legal • WARRANTY One year RTB • DETAILS <a href="http://www.canon.co.uk">www.canon.co.uk</a> • PART CODE 9539B008AA • FULL REVIEW Aug 2015</p>	
OFFICE PRINTER	<p><b>COMPUTER SHOPPER</b> BEST BUY ★★★★★</p> <p><b>HP</b> Officejet Pro X476dw</p> <p>£325 inc VAT • <a href="http://www.ebuyer.com">www.ebuyer.com</a></p> <p>It may be an inkjet, but HP's MFP beats most colour lasers in terms of speed, print quality and running costs.</p> <p>TECHNOLOGY Thermal inkjet • MAXIMUM PRINT RESOLUTION 2,400x1,200dpi • SCANNER RESOLUTION 1,200x1,200dpi • DIMENSIONS 517x517x399mm • WEIGHT 24kg • MAXIMUM PAPER SIZE A4/legal • WARRANTY One year onsite • DETAILS <a href="http://www.hp.co.uk">www.hp.co.uk</a> • PART CODE CN461A • FULL REVIEW Mar 2015</p>	

# Choosing an ...

## Action camera

**01** Action cameras are typically much smaller than regular camcorders, as they're designed to be mounted on a bike, board or car, or attached to your own body. As the name suggests, they're designed primarily for shooting action footage, but because of their small size they're ideal for strapping on to your pet's collar or your children's toys for a different perspective.

**02** Almost all action cameras will shoot Full HD video, and some will even shoot 4K, but the frame rate is arguably more important than resolution when it comes to action video. Higher frame rates will mean smoother clips, and super-high frame rate videos can be played in slow motion to emphasise exciting shots. Keep an eye out for 4k/30p, 1080p/60 and 720p/120 models for the widest possible choice of resolutions and frame rates.

**03** Most action cameras use flash memory cards to store your video, so you can swap these out on the fly when you fill one up with video footage. Some of the more expensive devices have integrated flash memory as well as a card slot, but it's typically cheaper to buy the basic version of a camera and pick up memory cards separately.

**04** Not all action cameras have LCD screens – in fact, many deliberately do without a screen to extend battery life. If you like to see exactly what you're pointing the lens at, keep an eye out for cameras that have their own smartphone companion apps, or wrist-mounted viewfinders that also let you start and stop shooting remotely.

**05** Action cameras typically have a huge range of optional accessories, with specific mounts and harnesses for different activities and sports. If the camera itself isn't water resistant, a weatherproof case will protect it from the elements, while a tripod mount will let you lock it firmly in place. Spare batteries are essential for longer shoots, and some decent video-editing software will help you produce a more polished result.

### NETWORKS



#### TP-LINK Archer C9

★★★★★

£105 inc VAT • [www.pcworld.co.uk](http://www.pcworld.co.uk)

It doesn't have a modem, so you'll need to pair it with your ISP's cable, ADSL or fibre modem, but the Archer C9 is an incredibly capable router with plenty of features and fantastic wireless performance.

WI-FI STANDARD 802.11ac • STATED SPEED 1,900Mbit/s • USB PORTS 1x USB3, 1x USB2 • LAN PORTS 4x Gigabit • WALL MOUNTABLE No • WARRANTY Three years RTB • PART CODE Archer C9 • DETAILS [uk.tp-link.com](http://uk.tp-link.com) • FULL REVIEW Sep 2015



WIRELESS ROUTER



#### BT Dual-Band Wi-Fi Extender 1200

★★★★★

£50 inc VAT • [www.shop.bt.com](http://www.shop.bt.com)

This fast wireless extender is easy to set up and is the perfect companion to an 802.11ac router. The wired LAN port lets you connect a wired device to your wireless network, too.

WI-FI STANDARD 802.11ac • STATED SPEED 867Mbit/s • LAN PORTS 1x 10/100 • WARRANTY Three years RTB • PART CODE 80462 • DETAILS [connectedhome.bt.com](http://connectedhome.bt.com) • FULL REVIEW Aug 2015



WI-FI RANGE EXTENDER



#### DEVOLO dLAN 1200+ Starter Kit

★★★★★

£110 inc VAT • [www.scan.co.uk](http://www.scan.co.uk)

Devolvo's dLAN 1200+ is the fastest Powerline networking kit we've seen, even if you're limited to a single Gigabit Ethernet connection. The passthrough sockets are very convenient, too.

POWERLINE NETWORKING STANDARD HomePlug AV2 • STATED SPEED 1,200Mbit/s • ADAPTORS IN BOX 2 • WARRANTY Three years RTB • PART CODE 09378 • DETAILS [www.devolvo.com/uk](http://www.devolvo.com/uk) • FULL REVIEW Feb 2015



POWERLINE KIT



#### ASUS EA-AC87

★★★★☆

£117 inc VAT • [www.box.co.uk](http://www.box.co.uk)

It's much larger than the average range extender, but that's only to make room for a whopping five Gigabit Ethernet ports. The EA-AC87 can also act as a Wi-Fi access point.

MODEM None • WI-FI STANDARD 802.11ac • STATED SPEED 1,734Mbit/s • USB PORTS 0 • WALL MOUNTABLE Yes • LAN PORTS 5x Gigabit • WARRANTY Two years RTB • PART CODE 90IG01A0-BU9000 • DETAILS [www.asus.com](http://www.asus.com) • FULL REVIEW Sep 2015



WIRELESS BRIDGE

#### D-LINK DSL-3590L

★★★★☆

£158 inc VAT • [www.dabs.com](http://www.dabs.com)

If you want to ditch your ISP-provided modem router, D-Link's DSL-3590L should be your first choice. It might not have the fastest Wi-Fi speeds but the feature list is impeccable.

MODEM ADSL2+ • WI-FI STANDARD 802.11ac • STATED SPEED 1,900Mbit/s • USB PORTS 1x USB3, 1x USB2 • LAN PORTS 4x Gigabit • WALL MOUNTABLE No • WARRANTY Two years RTB • PART CODE DSL-3590 • DETAILS [www.dlink.com](http://www.dlink.com) • FULL REVIEW Sep 2015



MODEM ROUTER

### VIDEO



#### AMAZON Fire TV Stick

★★★★☆

£35 inc VAT • [www.amazon.co.uk](http://www.amazon.co.uk)

This bargain media-streaming device excels for Amazon Prime subscribers. Even if you're not, you'll get good mileage out of it with platforms such as Plex. It's our favourite discrete streaming device.

VIDEO OUTPUTS HDMI 1.4 • NETWORKING 802.11n • STREAMING FORMATS UPnP, AirPlay, DLNA • INTERNET STREAMING SERVICES iPlayer, Netflix, Sky News, Spotify, TuneIn Radio, Amazon Instant Video, TVPlayer • DIMENSIONS 115x15x17mm • WARRANTY One year RTB • PART CODE Fire TV Stick • DETAILS [www.amazon.co.uk](http://www.amazon.co.uk) • FULL REVIEW Aug 2015



MEDIA-STREAMING STICK



#### GOPRO Hero4 Black

★★★★★

£270 inc VAT • [www.simplyelectronics.net](http://www.simplyelectronics.net)

The GoPro Hero4 Black doesn't deviate from the existing GoPro template but is an excellent action camera that introduces stunning 4K video at 30fps. You also get support for a wide range of mounts and accessories, meaning you'll be able to capture fantastic footage whatever the activity.

SENSOR 1/2.3in CMOS • SENSOR PIXELS 12,000,000 • MAX RECORDING RESOLUTION 4K (30fps) • AV CONNECTIONS Micro HDMI output, 3.5mm microphone to Mini USB (optional) • DIMENSIONS 41x59x30mm • WEIGHT 89g (85g with housing) • WARRANTY One year RTB • PART CODE CHDHX-41-EU • DETAILS [www.gopro.com](http://www.gopro.com) • FULL REVIEW May 2015



ACTION CAM



#### HUMAX HDR-1100S 500GB

★★★★★

£190 inc VAT • [www.johnlewis.com](http://www.johnlewis.com)

The Humax HDR-1100S is an attractive Freesat+ PVR that's easy to use and integrates catch-up TV seamlessly through Freetime.

TUNERS 2x DVB-S2 Freesat • DIMENSIONS 280x48x200mm • NETWORKING Gigabit Ethernet, 802.11n Wi-Fi • INTERNAL DISK CAPACITY 500GB • WARRANTY One year RTB • DETAILS [www.humaxdirect.co.uk](http://www.humaxdirect.co.uk) • PART CODE HDR-1100S-White • FULL REVIEW Dec 2015



FREESAT+ PVR



#### VEHO Muvi K2 NPNG

★★★★★

£239 inc VAT • [www.amazon.co.uk](http://www.amazon.co.uk)

The K2 packs in plenty of action camera features for a budget price, and comes with a generous number of accessories, including a useful hard transport case. Image quality is very respectable too.

SENSOR PIXELS 16,000,000 • MAX RECORDING RESOLUTION 1080p (60fps) • AV CONNECTIONS Mini HDMI • DIMENSIONS 40x25x60mm • WEIGHT 84g • WARRANTY One year RTB • DETAILS [www.veho-muvi.com](http://www.veho-muvi.com) • PART CODE K2NPNG • FULL REVIEW Dec 2015



ACTION CAMERA



#### PANASONIC HC-WX970

★★★★★

£598 inc VAT • [www.photospecialist.co.uk](http://www.photospecialist.co.uk)

This twin-camera 4K-capable camcorder lets you capture 8-megapixel stills from 4K video. It has superb image stabilisation and its HDR video mode can help with exposing difficult scenes.

OPTICAL ZOOM 20x • SENSOR 1/2.3in BSI MOS • LCD SCREEN 3in, 460,800 dots • DIMENSIONS 73x65x139mm • WEIGHT 360g • WARRANTY One year RTB • DETAILS [www.panasonic.com](http://www.panasonic.com) • PART CODE HC-WX970 • FULL REVIEW Sep 2015



CAMCORDER

# Choosing an ...

## Intel motherboard

**01** It's essential that you buy the right type of motherboard for your processor. Intel's older Haswell processors require a motherboard with an LGA1150 socket, but newer, fourth-generation Skylake chips need an LGA1151 socket. A board for a Haswell processor must also have an H97 or a Z97 chipset, while Skylake processors use the new Z170 chipset. Skylake CPUs also use newer, faster DDR4 memory.

**02** All current Intel processors have built-in graphics chipsets, so if you want to use your chip's built-in graphics, make sure the motherboard has the video outputs you need, such as VGA, DVI, HDMI and DisplayPort. If you want to play modern games, you'll need to fit a dedicated graphics card in the motherboard's PCI Express x16 slot, although this may block one of your other slots.

**03** Normal tower cases can accommodate ATX motherboards, which provide the most expansion slots. A microATX motherboard will let you build your PC in a smaller case, but if you opt for a microATX board, make sure it has all the features you need built in as there won't be much room for expansion cards.

**04** If you want to install lots of expansion cards, look for a motherboard that offers plenty of SATA2 and PCI-E x1 slots. Some motherboards also have PCI Express x4 slots and extra PCI Express x16 slots. PCI Express x1 and x4 cards also work in PCI Express x16 slots.






If you need a lot of storage, a motherboard with plenty of SATA2 and SATA3 ports is essential. SATA2 is fine for optical drives and hard disks, but to make the most of an SSD you need SATA3.

**05** All motherboards have built-in audio chipsets, but some support only 5.1 surround sound rather than 7.1. If you're connecting to older surround-sound amplifiers that don't have HDMI, look for an optical or coaxial S/PDIF output. All motherboards have Ethernet ports and most have the faster Gigabit version. You may also find it useful to buy a board with built-in Wi-Fi so you don't have to use up a USB port or PCI slot with an adaptor.

### COMPONENTS

GRAPHICS CARD	<p><b>COMPUTER SHOPPER RECOMMENDED</b> <b>MSI GTX 960 Gaming 2G</b> ★★★★★</p> <p>£160 inc VAT • <a href="http://www.scan.co.uk">www.scan.co.uk</a></p> <p>Nvidia's latest mid-range card is a fantastic performer at 1080p and will also play most titles at 1440p. It's whisper quiet too, switching its fans off completely when you aren't gaming.</p> <p>GPU Nvidia GeForce GTX 960 • MEMORY 2GB GDDR5 • GRAPHICS CARD LENGTH 367mm • WARRANTY Three years RTB • DETAILS <a href="http://www.msi.com">www.msi.com</a> • PART CODE GTX 960 GAMING 2G • FULL REVIEW May 2015</p> 
PROCESSOR	<p><b>COMPUTER SHOPPER RECOMMENDED</b> <b>INTEL Core i5-6600K</b> ★★★★★</p> <p>£200 inc VAT • <a href="http://www.dabs.com">www.dabs.com</a></p> <p>The Core i5-6600K is the first of Intel's latest processor generation. The unlocked multiplier means you can push it further when overclocking, and energy efficiency has never been better.</p> <p>SOCKET LGA1151 • CORES 4 • FREQUENCY 3.5GHz • INTEGRATED GRAPHICS Intel HD Graphics 530 • WARRANTY One year RTB • DETAILS <a href="http://www.intel.com">www.intel.com</a> • PART CODE BX80662I56600K • FULL REVIEW Nov 2015</p> 
PROCESSOR	<p><b>COMPUTER SHOPPER BEST BUY</b> <b>AMD A10-7700K</b> ★★★★★</p> <p>£91 inc VAT • <a href="http://www.scan.co.uk">www.scan.co.uk</a></p> <p>The A10-7700K strikes an excellent balance between desktop and graphics performance, making it the ideal all-rounder for an inexpensive PC build.</p> <p>SOCKET FM2 • CORES 4 • FREQUENCY 3.4GHz • INTEGRATED GRAPHICS AMD Radeon R7 • WARRANTY One year RTB • DETAILS <a href="http://www.amd.com">www.amd.com</a> • PART CODE AD770KXBJABOX • FULL REVIEW May 2015</p> 
MOTHERBOARD	<p><b>COMPUTER SHOPPER BEST BUY</b> <b>ASUS Z170-A</b> ★★★★★</p> <p>£114 inc VAT • <a href="http://www.ebuyer.com">www.ebuyer.com</a></p> <p>The Asus Z170-A is the best-value Skylake motherboard around right now, with performance and features that easily match those of more expensive boards without making a big dent in your wallet.</p> <p>PROCESSOR SOCKET LGA1151 • DIMENSIONS 302x244 • CHIPSET Intel Z170 • MEMORY SLOTS 4 • PCI-E X16 SLOTS 3 • PCI-E X1 SLOTS 3 • PCI SLOTS 1 • USB PORTS 2x USB2, 2x USB3, 2x USB 3.1 • VIDEO OUTPUTS HDMI, DVI, VGA, DisplayPort • WARRANTY Three years RTB • DETAILS <a href="http://www.asus.com/uk">www.asus.com/uk</a> • PART CODE Z170-A • FULL REVIEW Nov 2015</p> 
PC CASE	<p><b>COMPUTER SHOPPER RECOMMENDED</b> <b>SILVERSTONE Kublai KL05</b> ★★★★★</p> <p>£45 inc VAT • <a href="http://www.scan.co.uk">www.scan.co.uk</a></p> <p>With a serious amount of space for storage and cooling, Silverstone's latest Kublai mid-tower case is flexible enough to house almost any PC build.</p> <p>CASE TYPE ATX mid-tower • MOTHERBOARD COMPATIBILITY ATX, Micro-ATX, Mini-ITX • SUPPLIED FANS 1x 120mm • MAX 3 3.5in DRIVE BAYS 6 • MAX 5 3.5in DRIVE BAYS 2 • DIMENSIONS 200x494x525mm • WEIGHT 6.9kg • WARRANTY One year RTB • DETAILS <a href="http://www.silverstoneetek.com">www.silverstoneetek.com</a> • PART CODE SST-KL05B-W • FULL REVIEW Dec 2015</p> 

### SOFTWARE

WEB DESIGN	<p><b>COMPUTER SHOPPER BEST BUY</b> <b>XARA Web Designer 11 Premium</b> ★★★★★</p> <p>£70 inc VAT • <a href="http://www.xara.com/uk">www.xara.com/uk</a></p> <p>Web Designer was already excellent, but version 11 has received a slew of incremental updates that ensure it remains our favourite one-box web-design tool.</p> <p>OS SUPPORT Windows XP or later • MINIMUM CPU Intel Celeron/AMD Sempron • MINIMUM GPU DirectX 9 • MINIMUM RAM 500MB • HARD DISK SPACE 300MB • DETAILS <a href="http://www.xara.com.uk">www.xara.com.uk</a> • FULL REVIEW Sep 2015</p> 
DESKTOP PUBLISHING	<p><b>COMPUTER SHOPPER BEST BUY</b> <b>SERIF PagePlus X8</b> ★★★★★</p> <p>£90 inc VAT • <a href="http://www.serif.com">www.serif.com</a></p> <p>Get full control over the layout and appearance of your documents, from flyers to professional-looking publications. Version 8 adds a baseline grid, making text easier to line up, and improves photo editing.</p> <p>OS SUPPORT Windows XP or later • MINIMUM CPU Intel Pentium 4 or later, AMD Athlon 64 or later • MINIMUM GPU Not stated • MINIMUM RAM 512MB (Windows XP), 1GB (Vista, 32-bit Windows 7/8), 2GB (64-bit Windows 7/8) • HARD DISK SPACE 510MB • DETAILS <a href="http://www.serif.com/pageplus">www.serif.com/pageplus</a> • PRODUCT CODE N/A • FULL REVIEW Feb 2015</p> 
PHOTO EDITING	<p><b>COMPUTER SHOPPER BEST BUY</b> <b>ADOBE Photoshop Lightroom 6</b> ★★★★★</p> <p>£90 inc VAT • <a href="http://www.ebuyer.com">www.ebuyer.com</a></p> <p>Lightroom 6 might be a relatively modest update, but Adobe's photography toolbox still sets the gold standard for Raw processing and image enhancement.</p> <p>OS SUPPORT Windows 7/8 • MINIMUM CPU Intel or AMD with 64-bit support • MINIMUM GPU 1GB, OpenGL 3.3, DirectX 10 • MINIMUM RAM 2GB • HARD DISK SPACE 2GB • DETAILS <a href="http://www.adobe.com/uk">www.adobe.com/uk</a> • PRODUCT CODE 65237576 • FULL REVIEW Aug 2015</p> 
GRAPHIC DESIGN	<p><b>COMPUTER SHOPPER BEST BUY</b> <b>SERIF Affinity Designer</b> ★★★★★</p> <p>£40 inc VAT • <a href="http://itunes.apple.com">itunes.apple.com</a></p> <p>The first real competition to Adobe's Illustrator may be an OS X exclusive, but Affinity Designer is a seriously powerful graphic design tool that costs an incredibly reasonable £40.</p> <p>OS SUPPORT Apple OS X 10.7.5 • MINIMUM CPU Core 2 Duo (64-bit) • MINIMUM GPU Intel HD Graphics • MINIMUM RAM 1GB • HARD DISK SPACE 325MB • DETAILS <a href="http://affinity.serif.com">affinity.serif.com</a> • PRODUCT CODE Affinity Designer • FULL REVIEW Mar 2015</p> 
MUSIC PRODUCTION	<p><b>COMPUTER SHOPPER BEST BUY</b> <b>STEINBERG Cubase Artist 8</b> ★★★★★</p> <p>£220 inc VAT • <a href="http://www.steinberg.net">www.steinberg.net</a></p> <p>Music production software usually saves the best features for the priciest version, but that's not the case here, making Cubase Artist 8 an excellent investment for musicians aspiring to the highest standards.</p> <p>OS SUPPORT Windows 7 or later • MINIMUM CPU Intel Core/AMD dual-core • MINIMUM GPU DirectX 10 • MINIMUM RAM 4GB • HARD DISK SPACE 15GB • DETAILS <a href="http://www.steinberg.net">www.steinberg.net</a> • PRODUCT CODE 45550 • FULL REVIEW May 2015</p> 

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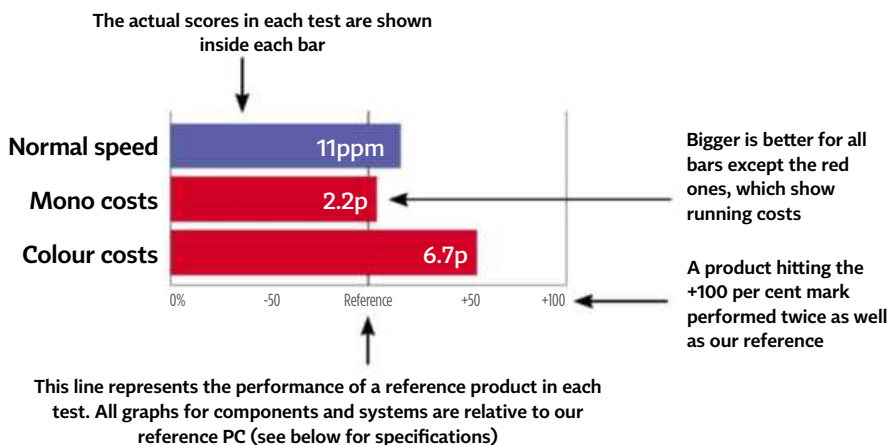
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# How we test

Find out how well products perform with the help of *Computer Shopper's* comprehensive tests

**COMPUTER SHOPPER'S REVIEWS** use some of the most exhaustive testing procedures you'll find in any PC magazine. Every product is subjected to qualitative and quantitative tests that show how it performs in practical use. Graphs for performance, battery-life scores and costs are used in the Reviews section, as shown on the right. Look in the 'Summary of tests' table (below) for details of each test we run.

For PCs and laptops, we evaluate performance using our own custom benchmarking suite. See below for a brief description of our benchmarking software and game tests.



## SUMMARY OF TESTS

PC SYSTEMS	
Windows overall	Average speed across numerous demanding tasks
Multitasking	Speed when running simultaneous applications
Dirt Showdown (1080p)	Frames per second at 1,920x1,080, 4xAAA, Ultra detail
Metro: Last Light Redux	Frames per second at 1,920x1,080, SSAA, Very High detail
LAPTOPS	
Windows overall	Average speed across numerous demanding tasks
Multitasking	Processor-intensive multitasking test
Dirt Showdown (720p)	Frames per second at 1,280x720, 4xAAA, High detail
Battery life	Run time in minutes for continuous video playback
SMARTPHONES/TABLETS	
Battery life	Run time in minutes for continuous video playback
PRINTERS AND MFPs	
Mono text speed	Pages per minute for correspondence-quality text
Mixed colour speed	Pages per minute for presentable text and graphics
Mono page cost	Running costs expressed as pence per page
Colour page cost	Running costs expressed as pence per page
DIGITAL CAMERAS	
Battery life	Number of shots from full charge
CAMCORDERS	
Battery life	Run time in minutes for recording
MP3 PLAYERS	
Battery life	Run time in minutes for continuous playback
ROUTERS	
Laptop 24GHz 10m	Mbit/s at 10m with 802.11n laptop on 24GHz band
Laptop 24GHz 25m	Mbit/s at 25m with 802.11n laptop on 24GHz band
Laptop 5GHz 10m	Mbit/s at 10m with 802.11n laptop on 5GHz band
Laptop 5GHz 25m	Mbit/s at 25m with 802.11n laptop on 5GHz band
802.11ac adaptor 10m	Mbit/s at 10m with an 802.11ac adaptor
802.11ac adaptor 25m	Mbit/s at 25m with an 802.11ac adaptor
NETWORK-ATTACHED STORAGE	
Large files	Average MB/s for read/write of 100MB large files
Small files	Average MB/s for read/write of 100MB small files
HARD DISKS	
Extra large files	Average MB/s for read/write of a single 2.5GB file
Large files	Average MB/s for read/write of 2.5GB of large files
Small files	Average MB/s for read/write of 2.5GB of small files
PROCESSORS	
Windows overall	Average speed across numerous demanding tasks
Multitasking	Speed when running simultaneous applications
Dirt Showdown (720p)	Frames per second at 1,280x720, 4xAAA, High detail
MOTHERBOARDS	
Windows overall	Average speed across numerous demanding tasks
Multitasking	Speed when running simultaneous applications
Dirt Showdown (1080p)	Frames per second at 1,920x1,080, 4xAAA, Ultra detail
Dirt Showdown (720p)	Frames per second at 1,280x720, 4xAAA, High detail
GRAPHICS CARDS	
Dirt Showdown (1080p)	Frames per second at 1,920x1,080, 4x MSAA, Ultra detail
Tomb Raider	Frames per second at 1,920x1,080, SSAA, Ultra detail
Metro: Last Light Redux	Frames per second at 1,920x1,080, SSAA, Very High detail

## BENCHMARKS

### SHOPPER BENCHMARKS

Our benchmark suite uses open-source software that runs on Windows, Mac OS X and Linux systems. This lets us use objective results to compare PCs and laptops, no matter which operating system they run. It's designed to test each computer to its limit, using a combination of intensive image-editing, video-encoding and multitasking tests.

We ran the tests on our reference PC, which has an Intel Core i5-4670K processor, 8GB of DDR3 RAM and an AMD Radeon R7 260X graphics card. We normalised our results so this PC had a score of 100. This makes it easy to draw comparisons between test systems.

The resulting overall score is shown at the bottom of every PC and laptop review. As we use the same tests in our standalone and group test reviews, you can compare the performance of any computer, whether it's a netbook, laptop or desktop, from both sections of the magazine.

To see how your computer compares, you can download the suite from [www.shopperdownload.co.uk/benchmarks](http://www.shopperdownload.co.uk/benchmarks). Versions are available for 32-bit and 64-bit operating systems.

### 3D BENCHMARKS

#### DIRT SHOWDOWN

Dirt Showdown is a cracking racing game that makes good use of DirectX 11's fancy graphical effects. You'll want at least 30fps for smooth racing.



#### TOMB RAIDER

With the ultra-demanding Super-Sampling Anti-Aliasing (SSAA) enabled, 2013's Tomb Raider reboot is a great indicator of mid-range performance.



#### METRO: LAST LIGHT REDUX

Our most demanding graphics test uses tessellation, SSAA and massive textures to give even high-end cards a thorough workout.



## RATINGS & AWARDS

Computer Shopper rates products out of five:

- Avoid ★☆☆☆☆
- Below average ★★☆☆☆
- Good ★★★☆☆
- Very good ★★★★☆
- Excellent ★★★★★

The best products can win the following awards:

### BEST BUY

Products with outstanding quality and performance for the money win our Best Buy award.



### RECOMMENDED

Products that don't quite qualify for a Best Buy award but are still highly rated by our reviewers.



### BUSINESS

The very best products for work win our Business Buy award.





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# Free software guide

Your free gifts are now even easier to enjoy. Just download all the software from [www.shopperdownload.co.uk/335](http://www.shopperdownload.co.uk/335) and register with your unique coupon code

## Silver Projects Premium



**SILVER PROJECTS PREMIUM** converts your colour photos into outstanding monochrome pictures.

The program doesn't require any photographic knowledge or artistic ability. Just open your target image and it will automatically apply a host of effects, optimising exposure, enhancing detail, removing noise and generally delivering great results.

Choosing one of the 30+ filters in the left-hand sidebar will immediately apply new effects, maybe optimising lighting or detail, softening or sharpening the image in new ways, giving the picture an 'old photo' or pencil sketch look, even adding frames of various types.

It's a solid selection of tools that really does have something for everyone, but if you'd like to take more control then the program's Expert Mode enables you to tweak every single detail.

Select the 'Natural high quality' filter, for instance, and you'll see the six effects it uses. These can be individually adjusted, or you're able to remove some,



and maybe introduce others. Experts can even try their own custom greyscale conversion method, or apply a new photo film emulation type.

Setting this up can take a while, of course, but you only have to do it once. Your current project can be saved for easy recall later, and there's also a batch-processing tool for speedily converting an entire folder of images in a single operation.

**REQUIREMENTS** Windows XP, Vista, 7, 8 or 10, Mac OS X 32/64-bit, 500MB hard disk space  
**WEBSITE** [www.projects-software.com](http://www.projects-software.com)  
**NOTES** Serial code is embedded within the software

### GETTING STARTED

The download instructions on the opposite page show you how to connect to the download site. Please make sure that you type in the web address exactly as shown. You'll need your coupon code the first time you log on.

### ANY PROBLEMS

If you need help with any of the software this month, please send an email to [letters@computershopper.co.uk](mailto:letters@computershopper.co.uk). We check this inbox regularly. Please include the issue number of the magazine and your coupon code.

### WHY DOWNLOADS

Software manufacturers have been requiring us to use online registration for some time now, but increasingly we're being asked to provide the program as a download. In order to continue bringing you the best free software, we've revamped our download site. You need to use the unique code printed in the box on the facing page to register and download the software in this issue.

The unique code means we stop the deals leaking online, so only *Shopper* readers get the software. You'll also enjoy a smoother registration, where we handle the registration process.

### NO CODE?

If you don't have the card insert with the unique code, you must buy the £4.99 print version of the magazine. If you have bought this, please contact [letters@computershopper.co.uk](mailto:letters@computershopper.co.uk) for help and a new code.

## Ashampoo Photo Commander 12

**ASHAMPOO PHOTO COMMANDER 12** is a one-stop tool for organising, browsing, editing and sharing your digital images.

The program opens with a powerful thumbnail browser. This supports a range of formats, including PSD, many Raw variants, MPO/JPS 3D images and WEBP. Every image is displayed along with its key details: resolution, colour depth, aspect ratio, DPI, EXIF and DMP tags. You can filter photos by type, age, name or tag, rate them with a click, then organise them into virtual albums.

Photo Commander provides several automatic optimisation tools. It can fix contrast and colours, remove noise, reduce compression artefacts and more, or you can apply the whole lot in a couple of clicks.

The real power comes in manual editing, though. You can crop or resize an image, straighten horizons, remove red-eye, repair scratches and apply various special effects, either globally or with a pen for pixel precision. A dual-view mode means you can see the 'before' and 'after' images side by side.

If you're feeling creative, *Ashampoo Photo Commander* enables you to share your images as calendars, collages, greetings cards or HTML albums. It can burn your favourite pictures to a CD or DVD-based slideshow, too.

Effects and tool tweaks include a smarter flood fill, with support for filling by colour tolerance. The Colour Accent effect allows you to click on one colour and have that remain, while everything else is greyed out. Manual white balance similarly alters the white balance of your photo based on a single click, while you're now able to select and cut out an object from a photo, make parts of an image transparent, or exchange transparent areas with another photo.



**REQUIREMENTS** Windows XP, Vista, 7 or 8 32/64-bit, 100MB hard disk space  
**WEBSITE** [www.ashampoo.com](http://www.ashampoo.com)  
**NOTES** Get your registration code within the application

## Chat and Communication

**Digsby (Build 92)** Access all your instant messaging services from one application; there's support for Windows Live!, Yahoo!, AIM, Google Talk, ICQ and Jabber.

**Evernote 5.9** Store your notes, ideas and plans in the cloud, and synchronise them between computers.

**UPDATED Mozilla Thunderbird 38.3** A powerful email client from the organisation best known for the Firefox web browser.

**Postbox Express 1.0** An email client that provides a comprehensive array of tools to help you manage your messages more easily.

**UPDATED Skype for Windows 7.12** Make internet voice and video calls for free, and buy credit to make calls to mobiles and landlines.

**Trillian 5.6** Use all your instant messaging accounts with one application; this program has support for Windows Live!, AIM, Yahoo! and Google Talk.



## Customisation

**7 Taskbar Tweaker 5** Customise the Windows 7 taskbar so that it works exactly to your liking.

**Metro UI Tweaker for Windows 8** Tweak the Windows 8 user interface.

**Mosaic Desktop Beta 1 Refresh**

Add Windows 8's mosaic-tiled desktop to your computer without having to upgrade.

**Rainmeter 3.2.1** Customise the desktop quickly and easily with your choice of information, tools and shortcuts.

**Windows 8 Transformation Pack 9.1** Emulate the look of Windows 8 on an earlier version of the operating system.

**Windows 10 Transformation Pack 5** Bring some of Windows 10's new features to your current operating system.



## General

**Free Studio 6.5** This software provides an easy way to convert your video and audio files into different formats.

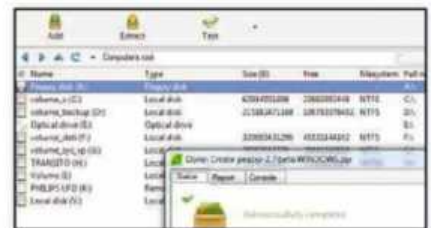
**Paragon Partition Manager 14 Free** Create, format, split, merge and reorganise all your hard disk's partitions.

**UPDATED PeaZip 5.8** A tremendously powerful archive-management tool.

**Screenshot Captor 4.12** Create and manage screenshots the easy way.

**SUMo 4.1** Quickly scan your PC's installed applications and find any updates that are available for them.

**ZipGenius 6.3** A flexible file-compression tool with support for a huge number of compressed file formats.



## Internet and Network

**CarotDAV 1.12**

Manage all your online storage services with one simple application.

**Cyberduck 4.7**

A powerful but easy-to-use FTP client for uploading and downloading your files.

**Easy WiFi 4.0**

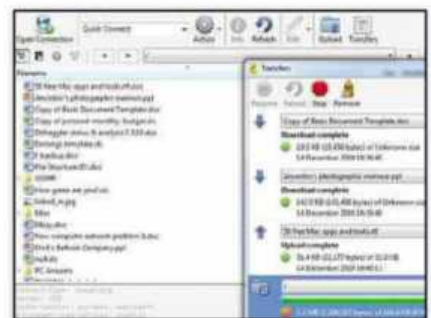
Find free Wi-Fi hotspots while you're out and about.

**NetBalancer 8.9**

Make the most of your internet connection by assigning download and upload priorities to web applications.

**TeamViewer 10.0** Remote-control your computer from anywhere in the world.

**Vuze 5.6** A BitTorrent client to help you locate, share and download torrent files.



## Tweaking and Performance

**UPDATED CCleaner 5.10** Remove unwanted information, temporary files, browsing history, huge log files and even the settings that uninstalled software leaves behind.

**Defraggler 2.19** Ensure your system is defragmented properly and improve its performance.

**Finestra Virtual Desktops 2.5** Set up four or more virtual desktops on your PC.

**IObit Advanced SystemCare 8.4**

A complete computer security, maintenance and optimisation suite.

**Revo Uninstaller Free 1.95** Remove installed applications completely, including all their folders, system files and Registry entries.

**Simple Performance Boost 1.0.5** Tweak the Windows Registry to give your PC a performance boost.



## Crafting PCs the Scan way: Specification. Service. Satisfaction.



### Scan V1 Value System Home / Office PC

- Intel® Pentium® G3240 processor
- 4GB Corsair DDR3 1333MHz memory
- 500GB SATA 6Gb/sec hard drive
- Windows 10

**£310** Inc VAT

The V1 is a very capable entry-level system perfect from basic home/office tasks. It's based around the dual-core Intel® Pentium® G3240 processor, 4GB of RAM plus a 500GB hard disk.



### Scan V15 Value System Home / Office PC

- Intel® Core™ i5 4460 processor
- 8GB Corsair DDR3 1600MHz memory
- 1TB SATA 6Gb/sec hard drive
- Windows 10

**£490** Inc VAT

The V15 ups the ante by including a quad-core Intel® Core™ i5 4460 processor, so it makes light work of office and multimedia applications.



### Scan G20 Value System Gaming PC

- Intel® Pentium® G3240 processor
- 8GB Corsair DDR3 1600MHz memory
- 2GB NVIDIA GeForce GTX 750 Ti SSC
- 1TB SATA 6Gb/sec hard drive
- Windows 10

**£489** Inc VAT

Thanks to its dual-core Intel® Pentium® G3240 processor and NVIDIA GTX 750 Ti SSC graphics card the G20i is our most affordable gaming PC. It even includes surround sound!



### Scan G30i Value System Gaming PC

- Intel® Core™ i5 4460 processor
- 8GB Corsair DDR3 1600MHz memory
- 2GB NVIDIA GeForce GTX 960 SSC ACX
- 1TB SATA 6Gb/sec hard drive
- Windows 10

**£679** Inc VAT

The combination of quad-core Intel® Core™ i5 4460 processor and NVIDIA GeForce GTX 960 SSC ACX graphics card ensures that the G30i can play any game you throw at it.



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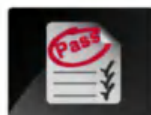
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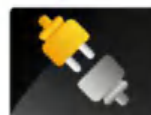
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- 4GB NVIDIA GeForce GTX 970 SC ACX
- 1TB Seagate HDD
- Windows 10
- 3 Year Premium Warranty

**£999** inc VAT

The 3XS Gamer 20i is a super-fast gaming PC thanks to its combination of quad-core Intel Core i7 4790 CPU running at 3.6GHz with added Hyper-Threading plus a 4GB NVIDIA GeForce GTX 970 graphics card. These components are installed in an Asus Z97-K motherboard along with a 1TB hard disk.



### Scan 3XS Vengeance Gaming PC

- Intel® Core™ i7 6700K processor overclocked up to 4.7GHz
- 8GB Corsair DDR3 2133MHz memory
- 4GB NVIDIA GeForce GTX 980 SC
- 250GB Samsung 850 SSD & 2TB HDD
- Windows 10
- 3 Year Premium Warranty

**£1529** inc VAT

This high-end gaming system includes a Intel Core i7 6700K CPU which has Hyper-Threading and is overclocked up to 4.7GHz plus a 4GB NVIDIA GeForce GTX 980 graphics card, 8GB of 3000MHz Corsair Vengeance DDR4, an Asus Z170 Pro Gaming motherboard, 256GB PCI-E SSD and a 2TB hard disk.



### 3XS LG15 Performance GTX

- Intel® Core™ i7 6700HQ processor
- 8GB Corsair DDR3 1600MHz memory
- 2GB NVIDIA GeForce GTX 960M
- 15.6in 1,920 x 1,080 screen
- 1TB SATA 6Gb/sec hard drive
- Windows 10

**£879** inc VAT

The LG15 Performance GTX is a 15.6" mid-range gaming laptop that includes a NVIDIA GeForce GTX 960M graphics card plus your choice of Intel Core i5 or i7 CPU, up to 16GB of RAM and multiple hard disks and SSDs.



### 3XS LG15 Carbon G-Sync

- Intel® Core™ i7 6700K processor
- 8GB Corsair 2133MHz DDR4 memory
- 6GB NVIDIA GeForce GTX 970M or 980M
- 15.6in FullHD or 4K screen
- 1TB SATA 6Gb/sec hard drive
- Windows 10

**£1379** inc VAT

The LG15 Carbon G-Sync is a 15.6" high-end gaming laptop that includes a NVIDIA GeForce GTX 970M or 980M graphics card with your choice of Intel Core i5 or i7 CPU, up to 32GB of DDR4 and multiple hard disks and SSDs plus NVIDIA G-Sync for tearing and stutter free gaming.



## Scan Computers recommends Windows.

### 3XS Custom Series

Our 3XS Custom Series is a range of computers designed to offer the best performance for a variety of applications, with a particular focus on games. We build Custom Series PCs to order, so we can configure and tailor make an individual PC just the way you want it. We can also overclock the processor, so you get a faster PC without a substantial increase in price. All 3XS Custom Series PCs are covered by a three year warranty as standard with the first year on-site.



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3 Year Warranty

# 3XS SYSTEMS



# SMARTPHONES

## Contract killers

Before you splash out on the latest flagship handset, it's worth looking at some of the older models. Last year's super-phone is this year's bargain, as we show with our test of 18 great-value smartphones from the past and present

**THERE ARE SOME** certainties in life. The sun will rise in the east and set in the west, the England football team will enter a tournament high on promise and crash out spectacularly, and new and faster smartphones will be released like clockwork, riding a wave of hype.

While smartphones are getting better and better, particularly in their processors and screens, that doesn't mean the newest, fastest model on the market is worth the best part of £800 over a two-year contract.

There's a wealth of mid-range handsets available that won't make a massive dent in your bank balance. Better yet, you can buy a flagship handset from a year or two ago. Buying either an older flagship or a new mid-range handset and pairing it with a SIM-only deal is considerably cheaper than signing up for a typical 24-month contract, too. On page 90 we look at what some of the

best smartphones we've tested this month will cost you over 24 months on the UK's major networks, so you can see the real total cost of ownership for each model. Meanwhile, here's what to look for when choosing your bargain smartphone.

### OPERATING SYSTEM

All but one of the smartphones on test this month run the Android operating system, the exception being Apple's iPhone 5c, which runs iOS. We haven't included any Windows 8 phones, as we don't think they're worth considering until Windows 10 for phones is properly released.

Android is by far the most popular smartphone OS, running on around 80% of handsets. The sheer prevalence of Android smartphones means there's a wide range of designs and prices. The frequent new releases

of more powerful handsets also drives the cost of older models down quickly, creating the potential for some serious bargains.

As manufacturers tend to customise their versions of Android, however, handsets vary in how well they're supported. It's not guaranteed that a certain handset will receive the latest Android version. The most recent version is Android 6.0 Marshmallow, but we've tested handsets this month that are stuck on Android 4.4 KitKat.

Older versions of Android are by no means bad, but they lack some of the capabilities of the newer versions. According to Google, Android KitKat is still on 38.9% of Android devices, with 23.5% split between Android 5.0 and 5.1. No figures are available for Android 6.0, which has just started rolling out to Nexus devices at time of writing. With so many people still on 4.4, you needn't worry

about app support drying up, but phones with older versions of Android may start running into compatibility problems.

**SCREEN TIME**

Smartphones come in all manner of sizes. Whether you want a gargantuan phablet with a large screen or something that fits easily in your pocket, you have plenty of choice.

A 6in smartphone screen is not only fantastic for watching films but the extra area makes simple acts such as browsing the web more comfortable. The obvious trade-off is that these phones are big and relatively heavy.

Not everyone wants such a big phone, as they can be difficult to use with one hand. It's always worth going to a phone shop to get a feel for how the different sizes of handset sit in your hand and in your pocket (you may want to ask a shop assistant first).

Screen resolution, as well as sheer size, is also important. Resolutions can range from

anywhere up to 2,560x1,440 – for the LG G3 and Google Nexus 6 – down to 960x540 for the Samsung Galaxy A3. A lower resolution can still look great on a smaller screen, however. It's the combination of a lower-resolution display and a large screen that makes things look decidedly fuzzy.

Screen quality is also important, which is why we use a colour calibrator to test the contrast, brightness levels and colour accuracy of each phone's display.

Modern smartphones really are genuine computers in your pocket, with dual-core and even quad-core processors that provide plenty of processing power. The processor clock speed can play a role in just how swift a smartphone feels, whether you're just navigating around the operating system or browsing the web. Sometimes updates to newer versions of Android or iOS can make older phones feel sluggish, though, and we mention such cases in our reviews.

We use a set of benchmarks to test each smartphone's browsing, processor and 3D graphics performance. You can see how all the models we've tested stack up in our graphs on page 89. We're struck by just how well some of the older flagship phones compared with modern handsets.

We also test each handset's battery life with our continuous video playback test. This gives you an idea of whether a phone will get you through a typical day of use without you needing to charge it.

**MEMORY BANK**

It's surprising how quickly a phone's internal storage can fill with apps and media files. We'll let you know how much storage each phone has and whether or not you can add to it using a microSD slot. Many older phones provided microSD card slots to let you expand the internal storage cheaply, but these are becoming increasingly rare.

**The SIM-free smartphones on test this month**



## APPLE iPhone 5c



£200 inc VAT (refurbished) • From [www.refurb-phone.com](http://www.refurb-phone.com)

### VERDICT

It's the cheapest way to get an iPhone, but the 5c is starting to feel sluggish

**YOU CAN'T BUY** the iPhone 5c new any more, but refurbished units are still available for around £200. When even the two-year-old iPhone 5s costs more than £350 SIM-free, the 5c is the only relatively inexpensive way to get an iPhone.

Specification-wise, the 5c is an iPhone 5 in new clothing, which means its underlying technology is three years old now. It's made of plastic but is classier than this might suggest. With a single piece of moulded polycarbonate, the iPhone 5c feels incredibly well made, with no gaps or joins in the case. Plastic phones can sometimes feel a bit creaky, but Apple's contains a steel frame that makes the handset feel tough and durable. Finally, the outside is lacquered to help reduce scratching.

The screen is still one of the phone's highlights, as it uses the same 4in screen as the iPhone 5 and iPhone 5s. With a resolution of 1,136x640 and a high pixel density of 326ppi, this Retina screen still looks fantastic and very sharp. It also performed well in our colour calibrator tests.

We measured the screen's brightness as 501cd/m<sup>2</sup>, which is exceptionally bright, so you won't have any trouble using the phone outside. The 1,077:1 contrast ratio gives images plenty of punch, too, and the phone reproduces an almost-perfect 98.7% of the sRGB gamut.

It's an impressive screen, but it feels cramped by modern standards, especially for browsing the web. There's a reason why the current iPhone has a 4.7in display and most Android devices have at least 4½in screens.

The iPhone 5c is powered by a 1.3GHz ARM-based Apple A6 processor and 1GB of RAM. This dual-core chip is still reasonably swift, but updates to iOS have taken their toll – iOS 9 feels a little sluggish, with occasional stutters when opening and closing apps.

Despite this, the iPhone 5c's Peacekeeper browser score was exceptional at 1,252, though its Geekbench 3 single- and multicore scores of 690 and 1,250 won't set the world alight. The iPhone 5c doesn't support our



usual 3D graphics test, GFXBench GL Manhattan, so we ran the older T-Rex test instead. The iPhone 5c rendered 380 frames (6.8fps) in the offscreen test, which ignores the phone's screen resolution to make it easier to compare handsets. For comparison we also ran the T-Rex test on the £298 Sony Xperia Z3 Compact, which produced a significantly better 1,538 frames and 27fps.

Battery life was far more impressive, at 11h 39m in our video-playback test.

The iPhone 5c's 8 megapixel iSight camera performs well in good lighting conditions, although its exposure was occasionally off. The camera starts to suffer in low light, though, with noise creeping into the picture.

The iPhone 5c feels tough and has a great screen, but its components are starting to show their age. For the price of this phone, you can buy a better Android phone brand new, such as Samsung's Galaxy A3, but if you really want an iOS phone, a refurbished iPhone 5c is a fairly inexpensive way to go about it.

## GOOGLE Nexus 5



£189 inc VAT (refurbished) • From [www.photovideodirect.co.uk](http://www.photovideodirect.co.uk)

### VERDICT

The Nexus 5 is fast, but its battery life and camera are below average

**WHEN GOOGLE FIRST** launched the Nexus 5, it was a bit of a bargain, offering a flagship specification at a mid-range price. Now that it's been superseded by the Nexus 5X (last year's bigger Nexus 6 wasn't really a direct replacement) the Nexus 5 has only just become available as a refurbished unit, but £189 for such a powerful device is certainly tempting. As it's a Nexus device, it will also receive new Android updates in a timely fashion – the phone has just been updated with Android 6 Marshmallow, for example.

The Nexus 5's 5in, 1,920x1,080-resolution display is now standard for high-end smartphones. There's not a lot to fault when it comes to the screen. It's bright, producing a maximum 476.9cd/m<sup>2</sup> brightness in our tests, and covers a respectable 92.9% of the sRGB colour gamut. Our only minor complaint is that its contrast ratio of 886:1 is merely average, and with a black measurement of 0.53cd/m<sup>2</sup>, it can't display very deep blacks.

Its quad-core processor runs at 2.3GHz, giving the phone seriously snappy

performance. It handled Android 6.0 with rarely any hesitation and had no problem with any of the new operating system's animations and visual flourishes.

The Nexus 5 scored 861 in our Peacekeeper browser benchmark, and while that's around half the score that today's flagship phones achieve, the Nexus 5 still handled media heavy websites with only the odd minor stutter. Its Geekbench single-core score of 822 and multicore score of 2,491 are excellent, however, and show that the Nexus 5 can still hold its own with newer smartphones. Sadly, its gaming performance was mediocre. A GFXBench GL Manhattan of 573 frames (roughly 11fps) in the offscreen test is decidedly middling.

With an 8-megapixel sensor, the Nexus 5's camera has a fairly low resolution by current standards, but shots taken in daylight were generally fine, with respectable colours and well-resolved details. They tended to be



noisier than we'd like, though, and sometimes lacked sharpness. You also lose detail quickly if you crop into your images, thanks to the sensor's relatively low pixel count.

Photos taken in low light are much worse, and noise reduction resulted in some smudgy details.

The Nexus 5's camera is far from the best we've seen, and is the only real evidence of any compromises manufacturer LG made to keep the Nexus 5's original price down, but it's adequate for most uses.

The Nexus 5 is still an impressive handset, with an excellent Full HD screen and seriously fast performance. Its only real drawbacks are its camera and battery life – it managed just 7h 22m in our video playback test, which is three hours less than we expect to see from a modern smartphone.

While the Nexus 5 is still a decent smartphone, you can pick up a SIM-free LG G3, which has much better battery life and a far superior camera for not a lot more money.



## GOOGLE Nexus 6



£295 inc VAT • From [www.expansys.com](http://www.expansys.com)

### VERDICT

If you need a big-screen phone, the Nexus 6 still cuts the mustard

**WHEN YOU BUY** Google's Nexus-branded devices, you can expect timely Android updates as they're released. That's the case again here with the Motorola-manufactured Google Nexus 6, which has just been updated to Android 6.0 Marshmallow.

We like the Nexus 6's design. The rear is a delightful collision of lines and curves, all tapering to narrow edges that terminate in an aluminium frame. It feels tough and rigid, with a smooth, slightly soft rear panel that's a pleasure to hold. The headphone socket, camera lens, logos and USB port fall perfectly in line down the centre of the handset.

Despite forward-firing stereo speakers at the top and bottom for watching videos in landscape aspect, there's little in the way of bezel above and below the screen. In portrait mode, the upper speaker doubles as an earpiece for voice calls, while the lower one has the mic built in to keep everything neat.

The Nexus 6 has a giant 6in screen, so you'll definitely feel it in your pocket. The AMOLED display has the same 2,560x1,440

resolution as the LG G3's screen. The screen size reduces the pixels-per-inch figure to 493ppi, but that's still super-sharp. Its peak brightness of 268.9cd/m<sup>2</sup> is reasonable for an AMOLED display, and it provides the perfect black levels we've come to expect. The display covers 100% of the sRGB colour gamut, but we found colours a little over-saturated.

Performance from the Nexus 6 and its 2.7GHz Qualcomm Snapdragon 805 processor is excellent. It scored a strong 823 in our Peacekeeper browser test and felt responsive when navigating media-heavy websites, with little sign of stuttering.

In GFXBench GL Manhattan, the Nexus 6's performance actually increased following the upgrade to Android Marshmallow. It managed 1,122 frames (around 20fps) in the offscreen test, placing this phone in second place. Scores of 1,049 and 3,057 in the Geekbench 3 single- and multicore tests were also excellent.

For such a large phone, the Nexus 6's 3,220mAh battery isn't particularly big. This



wasn't a problem in our battery test, however, as it lasted for 12h 17m, so it should easily coast through a full day of usage.

The 13-megapixel camera did well in our indoor still-life tests. Images had a slightly green cast but showed plenty of detail and minimal noise. The Nexus 6 has a dual LED ring flash, which is more powerful than most flashes and is designed to diffuse the light. It works reasonably well but you still get the harshness of lighting associated with firing off a flash. Outside, the Nexus 6 took pictures with accurate colour and plenty of detail and dealt well with high-contrast scenes.

At £295, the Google Nexus 6 is still quite expensive. Granted, its SIM-free price has dropped considerably since launch, but there are plenty of cheaper alternatives, including the LG G3, which is roughly the same age. Better still, if you don't need a giant screen, buy the new Motorola Moto X Play, which is a fraction cheaper than the Nexus 6 and has a more up-to-date specification.

## HTC Desire 620



£161 inc VAT • From [www.expansys.com](http://www.expansys.com)

### VERDICT

A well-made phone with a good camera, but its mediocre screen and battery hold it back

**THE HTC DESIRE 620** is surprisingly large for a smartphone with only a 5in screen. At 150mm high, it's almost a full centimetre taller than Motorola's similar-sized Moto G 2nd Gen. This is partly to make room for HTC's BoomSound speakers at the top and bottom of the handset, but the bezels around the edge of the screen are also quite sizable, adding to the phone's overall bulk.

Compared with its predecessor – the Desire 610 – the 620 has a soft-touch matt chassis that looks smarter and feels better made. The larger, higher-resolution 5in 1,280x720 display is another welcome improvement as it makes text, icons and web pages much easier to read. We didn't have to zoom in quite so often when browsing desktop websites, and HTC's Sense 6.0 interface looked much sharper and more defined when browsing through Android 4.4's home screens.

It's just a shame that the display is of such poor quality. According to our colour calibrator, it displays a measly 76.5%

of the sRGB colour gamut. That compares unfavourably with most modern handsets, which tend to get close to 90%. Contrast was also a little below average at 682:1, which isn't helped by the phone's high black level reading of 0.46cd/m<sup>2</sup>.

The Desire 620 is powered by a quad-core Qualcomm Snapdragon 410 processor running at 1.2GHz, with 1GB of RAM. With a score of 703 in our Peacekeeper test, the phone still holds up relatively well compared with some of the more modern handsets, and it acquitted itself respectably when we used it to browse the web.

Sadly, its performance didn't hold up quite so well in the Geekbench 3 tests. Its single-core score of 474 is very low – behind that of even the Sony Xperia SP, which is definitely showing its age. At least the Desire 620 has a quad-core processor, so its multicore result of 1,980 comfortably beat that of the SP. Graphics performance was mediocre, too, with the phone rendering only 105 frames (roughly



1.7fps) in the GFXBench GL Manhattan offscreen test.

The Desire 620 doesn't even compensate for its poor performance with strong battery life. It lasted just 9h 42m in our continuous video playback

test with the brightness set to 170cd/m<sup>2</sup>, putting it near the bottom of the phones in our group test.

The Desire 620 redeems itself to a certain extent with its camera. Our test photos showed plenty of detail and bright, accurate colours. It had a tendency to overexpose the sky and clouds slightly in very bright conditions but we were pleased with the quality of our shots overall.

Although the HTC Desire 620 has a decent camera and its build quality is respectable, the far superior Motorola Moto G 3rd Gen provides similar performance, a better screen and longer battery life despite costing £10 less.

## HTC Desire 820



£220 inc VAT • From [www.mobilephonesdirect.co.uk](http://www.mobilephonesdirect.co.uk)

### VERDICT

The Desire 820's versatile camera and great screen make up for its lacklustre battery

**THE DESIRE 820** is one of the best budget big-screen phones we've seen, thanks to its gorgeous dual-colour unibody design. Without a single break in the chassis, it has a near seamless finish. The bezels are chunky, making the phone big for a model with a 5½in screen, but its svelte 7.7mm thickness means it's comfortable to hold.

The 5½in display has a lowly 1,280x720 resolution, so it's hardly the sharpest we've seen, but a pixel density of 267ppi means text is perfectly legible and icons are largely free of jagged edges. You can still see some jaggies if you peer in close, but at normal viewing distances we had no complaints.

Picture quality is fine, too. In our tests the Desire 820 displayed 90.8% of the sRGB colour gamut. Its main weakness is its red coverage, but the rest of the primary colours were evenly spread across the gamut, producing balanced, natural-looking images.

The display's high 440.69cd/m<sup>2</sup> brightness produces lovely clear whites and makes the phone easy to use outside. Unfortunately, the

flipside is that blacks appear quite grey – we measured a relatively high 0.41cd/m<sup>2</sup> black level.

The phone is powered by a 64-bit octa-core 1.7GHz Qualcomm Snapdragon 615 processor and has 2GB of RAM. The 64-bit processor is important for when the Desire 820 is updated to Android 5.0 Lollipop. This update has been slow in coming, though, and at time of writing had only just started rolling out.

The Desire 820 offers plenty of raw processing speed for the money. We were happy with its web browsing capabilities, as its score of 799 in Peacekeeper puts it only slightly behind Google's Nexus 6 and far above the Samsung Galaxy S4. Its Geekbench 3 single- and multicore scores of 694 and 2,569 are excellent, too. A year on from launch, the HTC Desire 820 is still a top performer.

Graphics performance isn't quite as impressive but is still respectable. In the GFXBench GL Manhattan offscreen test, it managed 349 frames (roughly 5.6fps). This



offscreen performance is considerably off the mark set by the Google Nexus 6, but you won't have problems with most Android games. Unfortunately, the Desire 820's processor takes its toll on the 2,600mAh battery, as it managed just 9h 18m in our continuous video playback test.

The phone has a 13-megapixel rear camera. Outdoor shots captured plenty of detail across the frame, and colours were bright and punchy. We noticed a loss of detail in lighter objects but overall we were pleased with the quality of the camera's shots. We were also pleased to see that switching to HDR mode didn't make our pictures look too unnatural. Instead, it helped even out the contrast and brought some much needed detail to the otherwise over-dark shadow areas.

With a good screen, excellent performance and capable camera, the Desire 820 has stood the test of time and is one of the best large budget phablets available today – especially now it's around £60 cheaper than at launch.

## LG G3



£245 inc VAT • From [www.ebuyer.com](http://www.ebuyer.com)

### VERDICT

The LG G3 is still an incredible smartphone with a fantastic camera

**WHEN THE LG G3** launched around 18 months ago, its super-high-resolution screen bowled us over. The handset is now half the price it was at launch and is incredible value.

Like its predecessor the G2, the G3 has power and volume buttons on the rear. This takes some getting used to but it means you don't press them accidentally when using the phone with one hand. We like the smooth curved back and ultra-thin bezels, but this is a big phone and its smoothness makes it easy to drop. We'd recommend investing in a case, such as the rubbery FlexiShield Dot LG G3 Case (£10 from [www.mobilefun.co.uk](http://www.mobilefun.co.uk)).

With a resolution of 2,560x1,440, the G3 crams a massive 3.68 million pixels into its 5½in display, giving it an astonishing pixel density of 534ppi. Its black levels aren't particularly deep at 0.56cd/m<sup>2</sup>, but this made little difference to the clarity of text because the screen's high brightness of 417.32cd/m<sup>2</sup> makes letters stand out against its clean white backgrounds. The display's high sRGB colour accuracy score of 91.7 per cent and high

measured contrast ratio of 74:1 led to plenty of detail in light and dark areas of images.

This is easily one of the best smartphone screens we've ever seen, although we noticed that the G3 couldn't sustain its maximum brightness setting for extended periods of use. Instead, it gradually lowered its maximum brightness level automatically, and wouldn't let us increase it again until the phone had cooled down.

For performance, the G3 still holds up well after its update to Android 5.0 Lollipop. The operating system generally runs smoothly, with only the occasional tiny stutter. Browser performance in our Peacekeeper benchmark was only average at 748, but media-intensive pages panned and zoomed smoothly. The G3 positively zips its way through the Geekbench 3 single core and multicore tests, too, with scores of 919 and 2,427.

The G3's graphics performance wasn't quite as good on paper as that of other



flagship handsets, but 591 frames (roughly 11fps) in the GFXBench GL Manhattan offscreen test is a respectable result.

The handset's huge 3,000mAh battery lasted an impressive 13h 12m in our video playback test. Its 16GB of storage might be a little limiting, but you can add a microSD card to provide more space for your media files.

The ½in 13-megapixel camera sensor uses laser autofocus technology. This means the camera supposedly takes just 0.276ms to focus on a subject, which is less than the blink of an eye. When taking landscape shots, the camera took no time at all to focus and the resulting images were well exposed, with plenty of fine detail.

The LG G3 has aged well. Its display is still top-notch and its performance highly impressive. It's also great value at around £245. At this price, it completely trounces many of the current crop of mid-range phones. It's a Best Buy.

## LG G4c



£210 inc VAT • From [www.expansys.com](http://www.expansys.com)

### VERDICT

**Exceptional battery life and a good camera, but its display lets it down**

**THE G4c IS** a smaller version of LG's leather-bound flagship, the 5½in LG G4. With a 5in display it's not exactly tiny, but like many of LG's 2015 handsets, its buttons are on the back, saving precious space on the front.

It's a nice-looking handset and doesn't feel too much like a cut-down G4. Unfortunately, the phone's most disappointing aspect by far is its 1,280x720 display. Not only is this a low resolution for such a large display, but our colour calibrator measured a meagre 65.9% sRGB colour gamut coverage, which is one of the lowest scores we've seen.

High brightness levels of 438.7cd/m<sup>2</sup> and clean-looking whites mask this to an extent, but warmer images looked plain wrong, with light skin tones appearing unnaturally peachy. Black levels were also quite high at 0.47cd/m<sup>2</sup>.

The G4c has an excellent battery life of 14h 43m, but rivals pull ahead for performance. The 1.2GHz quad-core Qualcomm Snapdragon 410 processor and 1GB of RAM simply can't compete with the Sony Xperia M4 Aqua's octa-core 1.5GHz Snapdragon 615, for

example, scoring just 1,405 in the Geekbench 3 multicore test. That's over 1,000 points behind its 615-based counterparts. Its score of 463 in the single-core test is even slower than that of the Samsung Galaxy A3, which also uses a 1.2GHz Snapdragon 410.

The phone's Peacekeeper browser test score of 632 is roughly in line with what we've seen from other Snapdragon 410 phones, but when scrolling around web pages the phone sometimes paused before responding to swipes. Graphics performance was also a little underwhelming, but no worse than that of other mid-range phones. The G4c produced just 107 frames in the offscreen Manhattan test in GFXBench Manhattan, which is roughly the same as the Motorola Moto G 3rd Gen and Samsung Galaxy A3 managed.

Only 3.45GB of the G4c's 8GB internal storage is available to the user, so it's not best suited to storing lots of games and apps. Fortunately, you can take advantage of the microSD card slot above the SIM card



slot if you want to store music and videos on your phone.

The rear 8-megapixel camera is a strong point. Its app is basic, with no extra modes or HDR shooting,

but images were surprisingly good at the default settings. Colours were rich and natural, and although overcast weather conditions during our test shots resulted in a rather bleached-out sky, there was plenty of detail and hardly any noise.

The G4c coped well indoors, too. Noise increased slightly, but colours had plenty of punch and compression was minimal. Turning on the flash gave everything a disappointing blue sheen, but it's better than nothing.

The LG G4c has a reasonable camera and fantastic battery life, but compared with Sony's Xperia M4 Aqua, Samsung's Galaxy A3 and the Moto G 3rd Gen, its poor screen, low storage capacity and mediocre performance simply don't measure up. You could also go for LG's own 18-month-old G3, which is a far superior phone for slightly more cash.

## MOTOROLA Moto G 2nd Gen



£135 inc VAT • From [www.ebuyer.com](http://www.ebuyer.com)

### VERDICT

**With a big screen and better camera, this is still a decent budget smartphone**

**ALTHOUGH THE 2ND** Gen Moto G has an older specification than the third-generation model, it costs £15 less, so it's still worth a look until the stock runs out. Just make sure you're buying the newer 4G-capable version.

You won't miss out on Android 5.0 Lollipop by choosing the Moto G 2nd Gen either, as the newer OS is available as a system update. The Moto G 2nd Gen comes in 8GB and 16GB models, and both allow you to expand the storage by up to 32GB using the microSD card slot. This is generally most useful for storing media files and photos, as some apps can be fussy about being installed to a memory card rather than internal storage.

The outstanding build quality of the original Moto G continues with this model. The Moto G 2nd Gen's curved back, which measures 6mm at its thinnest point and 11mm at its thickest, is comfortable to hold, and 149g is light for a large phone. The screen is also surrounded by the Moto G's front-ported dual speakers, which deliver impressive-sounding audio for your films and music.

The 5in, 1,280x720 display is beautiful. It's not the brightest screen we've seen, with a peak of just 350.7cd/m<sup>2</sup>, so you'll need to dial it up to near its maximum to see it clearly outdoors. Its sRGB colour gamut coverage of 87.2% is very respectable for such a cheap handset, though, as is its black level of 0.36cd/m<sup>2</sup>. Contrast was excellent at 960:1, and helped the screen produce plenty of detail in our test images.

Inside the Moto G 2nd Gen is a quad-core 1.2GHz Qualcomm Snapdragon 400 processor, which is beginning to show its age. This was especially evident in the Peacekeeper browser benchmark, where the phone scored only 494. Panning and zooming around complex websites wasn't particularly smooth, but its web browsing performance isn't terrible for a budget phone.

Its Geekbench 3 performance in the single-core and multicore tests was also respectable, with scores of 341 and 1,156



respectively. Graphics performance leaves a lot to be desired, however. Its score of 110 frames (roughly 1.8fps) in the GFXBench GL Manhattan offscreen test means that more taxing games such as Hearthstone will be out of reach.

The Moto G 2nd Gen has an 8-megapixel rear sensor with an f2.0 aperture. Outdoor shots looked rich and natural, with plenty of detail. The brickwork in our test scene was crystal-clear and the sky didn't suffer from any signs of overexposure. Objects further away were a little fuzzy compared with those in the foreground, but the camera is still a huge step up from most budget smartphone sensors.

The Moto G 2nd Gen is still a bargain. It's a £135 phone that gives a surprising number of £200-plus mid-range handsets a run for their money, and in most cases beats them hands-down for value. However, the superior Moto G 3rd Gen doesn't cost a lot more, and is worth the extra £15.

## MOTOROLA Moto G 3rd Gen

COMPUTER SHOPPER  
BEST BUY



£150 inc VAT • From [www.carphonewarehouse.com](http://www.carphonewarehouse.com)

### VERDICT

The newest Moto G is a fantastic phone with a great camera and long battery life

**NO-ONE DOES BUDGET** smartphones better than Motorola. For two years, the Moto G has reigned over every other cut-price handset, and the latest 3rd Gen model is the best yet.

That said, with prices from £150 to £209, the Moto G 3rd Gen isn't the straightforward bargain its predecessors were. The cheapest £150 model – which is the one sold through most retailers and networks – comes with just 8GB of storage and 1GB of RAM, for example.

If you want to choose your own colours and personalise the Moto G 3rd Gen using Motorola's Moto Maker service, you'll need to add £9 to that price, while the 16GB version (which comes with 2GB of RAM) costs £30 on top. At least the microSD card slot means buying extra storage is less of a problem.

A subtle ribbed texture on the back of the phone provides excellent grip, which is vital if you're going to use Motorola's ingenious hand gesture shortcuts. A double karate chop turns on the phone's rear torch, while a double twist of your wrist opens the camera. What's more, when the back is properly

clipped into place the Moto G can be dunked in up to one metre of water for up to 30 minutes without taking damage.

The screen is almost identical to that of the 2nd Gen phone. Both have 5in, 1,280x720-resolution displays, which strike just the right balance between size and clarity. Our colour calibration tests returned impressive results.

Inside the new Moto G is a quad-core Qualcomm Snapdragon 410 chipset. This regularly appears in budget smartphones, but here it runs at 1.4GHz rather than the usual 1.2GHz. This gives the phone a significant speed boost over the competition, and both the 1GB and 2GB versions of the Moto G proved significantly faster in our benchmarks than the competition. This doesn't come at the expense of battery life, either, which at 11h 12m in our tests is an hour and a half longer than that of the Moto G 2nd Gen.

Both 3rd Gen models scored around 530 in Geekbench 3's single-core test and 1,600 in the multicore test. They were equally fast at



web browsing, too, and the 1GB model's impressive Peacekeeper web browsing score of 781 is one of the faster scores we've seen

from this chipset. However, the real difference between the 1GB and 2GB Moto G is when multitasking. Apps and games loaded much faster on the 2GB than the 1GB version. There's often only a second between them, but the extra RAM does make a difference.

One of the biggest additions to the Moto G 3rd Gen is its 13-megapixel rear camera. It's a big step up from the 2nd Gen's 8-megapixel snapper, and according to Motorola, uses the same sensor as Google's Motorola-made Nexus 6 handset. Indoor and outdoor photos showed plenty of detail, and outdoor shots in particular looked superb. Colours were rich and vibrant and shadow areas detailed.

Even among some of the bargains we've seen in this group test, the Moto G 3rd Gen stands out as amazing value. The 8GB/1GB version wins a Best Buy award, and the 16GB/2GB model comes highly recommended.

## MOTOROLA Moto X 1st Gen



£195 inc VAT • From [www.handtec.co.uk](http://www.handtec.co.uk)

### VERDICT

The Moto X has a fantastic screen, but its processor is getting on a bit

**WHEN MOTOROLA LAUNCHED** its first Moto X in 2013, it redefined what we could expect from a mid-range handset. While not as fast as Google's Nexus 5, it had a great-looking 4.7in AMOLED screen and its snappy internals gave it plenty of speed. It's since been superseded by last year's Moto X 2nd Gen, but at less than £200 the older handset is still worth a look, especially now it's been upgraded to Android 5.1.

The Moto X 1st Gen sets itself apart from other mid-range handsets with its stunning 4.7in AMOLED screen. It may have only a 1,280x720 resolution, but text looked crisp and clear on desktop and mobile websites.

We were equally impressed with the screen's image quality. As we'd expect from an AMOLED display, colours look bright and punchy thanks to its 100% coverage of the sRGB colour gamut, and its perfect black level of 0cd/m<sup>2</sup> means blacks are so black they match the phone's glossy bezel.

The screen's whites are pure and clean, and a peak brightness level of 317.02cd/m<sup>2</sup>

makes the screen easy to see outside. It's easily as good as the Samsung Galaxy A3's screen, which also uses an AMOLED panel, but the Moto X has the added advantage of a higher resolution.

The Moto X's 1.7GHz dual-core Snapdragon S4 Pro processor has coped well with the update to Android Lollipop. There's no hesitation when navigating around the operating system, with everything feeling smooth and slick. Web browsing was less silky, however. We experienced the odd hiccup on graphic-intensive web pages and there was sometimes a delay when panning and zooming. The phone also falls behind the Sony Xperia M4 Aqua and Samsung Galaxy A3 in the Geekbench 3 processor benchmarks – a single-core score of 666 is average, as is 1,261 in the multicore test.

More impressive was the Moto X's Adreno 320 graphics processor. The same GPU powers the pricier Sony Xperia SP but, unlike



the Xperia SP, the Moto X managed to run our GFXBench GL Manhattan benchmark, with 335 frames (roughly 5.4fps) in the offscreen test. That won't set the world alight but you shouldn't have too many issues with casual games.

You needn't worry about draining the Moto X's large 2,200mAh battery, either, as it lasted a fantastic 12h 30m in our test.

The Moto X continues to distance itself from the rest of the mid-range competition with its 10-megapixel camera. Colours were bright and accurate in outdoor shots, with very little noise in larger expanses of colour. The sky was a little overexposed, but unlike other cameras in this price range, the Moto X was able to capture some cloud detail.

At just under £200, the Motorola Moto X is in competition with Samsung's £200 Galaxy A3 and Sony's £169 Xperia M4 Aqua. Its screen and camera are great but its processor is showing its age. The Samsung and Sony phones are more rounded choices.

## MOTOROLA Moto X Play

COMPUTER SHOPPER  
BEST BUY



£270 inc VAT • From [www.expansys.com](http://www.expansys.com)

### VERDICT

An excellent phone with a camera and battery that competes with the flagships

**THE MOTO X** 2nd Gen wasn't the successor to the Moto X that many expected. It went from mid-range marvel to something more resembling a flagship handset. The Moto X Play, then, could easily be considered the true successor to the original Moto X, with its much more wallet-friendly £270 price.

Unlike the Moto G 3rd Gen, the Moto X Play isn't completely waterproof. It's merely water resistant, so it will survive the odd splash or spill, as well as light rain, but won't fare so well with a thorough soaking.

The basic phone has 16GB of storage, but you can get 32GB for another £40. However, the microSD card slot accepts cards up to 128GB, so you're better off buying an inexpensive microSD card if you just want extra storage space for music or video files.

The Moto X Play has an octa-core, 1.7GHz Qualcomm Snapdragon 615 processor, and it's no slouch. Android 5.1.1 runs beautifully, with smooth menu animations and lightning-fast loading times. Likewise, the phone's performance in Geekbench 3, with its scores

of 708 and 2,567 in the single- and multicore tests respectively, is very impressive. These scores outstrip many of the Moto X Play's Snapdragon 615-based rivals, including the Sony Xperia M4 Aqua.

The Moto X Play drops the ball slightly for web browsing, as its Peacekeeper score of 828 is decidedly average compared with other 615-based handsets. There was some jerkiness when scrolling around image-intensive websites, even once they'd loaded.

Performance in the GFXBench GL offscreen Manhattan test was only average, with its score of 361 equating to roughly 5.8fps, but the Moto X Play was still able to run the 3D-effect-heavy *Hearthstone*, so you should be able to play any game on the Google Play Store without trouble. Battery life is good, too, as the handset's large 3,630mAh battery lasted 13h 8m in our test.

This is fantastic when you consider that the battery has to power a large 5½in, 1,920x1,080-resolution display. The screen is



very bright, too – our colour calibrator measured a massive 613.23cd/m<sup>2</sup> at its highest brightness setting, and its relatively

low black level of 0.36cd/m<sup>2</sup> was a surprise considering the screen's supreme brightness. Meanwhile, an sRGB gamut coverage figure of 91% is very respectable for a £270 phone, and colours were very evenly balanced.

The quality of the screen makes it a perfect viewfinder for the Moto X Play's 21-megapixel rear camera. Our initial test shots were excellent. Colours were rich and vibrant despite the cloudy weather, and there was plenty of fine detail present. Some of our shots were perhaps a touch dark in places, but this was quickly remedied by switching on the HDR mode, which helped illuminate images without making them appear too harsh or unnatural.

The Moto X Play is powerful and has a great screen and impressive battery life. If you're after a big, fast phone at a reasonable price, this is the one to get.

## SAMSUNG Galaxy A3

COMPUTER SHOPPER  
RECOMMENDED



£200 inc VAT • From [www.argos.co.uk](http://www.argos.co.uk)

### VERDICT

The reasonably priced Galaxy A3 feels like a much more expensive handset

**THE A3 IS** the smallest and cheapest phone in Samsung's Galaxy A series. When so many of its competitors at this end of the price range are swaddled in cheap plastic, the Galaxy A3's full metal unibody is a revelation. It's one of the lightest and slimmest phones Samsung has ever made, and the shimmering finish adds an extra level of class.

It's a shame that the phone's 4½in screen has a relatively low 960x540 resolution, as this makes web browsing trickier, particularly when viewing desktop sites. Many of the app icons on the main home screen look jagged and pixelated, too, and text isn't as sharp as we'd have liked either.

We had no complaints with the phone's Super AMOLED display. Our colour calibrator returned a perfect sRGB colour gamut score of 100% and a perfect 0.00cd/m<sup>2</sup> black level. With a peak brightness of 357.04cd/m<sup>2</sup>, it isn't the brightest display out there, but AMOLED displays are usually dimmer than their LCD counterparts, and the phone is perfectly easy to see outside, even in sunshine.

The Galaxy A3 is powered by a quad-core, 1.2GHz Qualcomm Snapdragon 410 processor and 1.5GB of RAM. This chipset is more than capable of running Android 5, but it means the Galaxy A3 is no faster than some budget handsets. Its Geekbench 3 scores of 474 and 1,418 in the single- and multicore tests are marginally behind those of the cheaper Motorola Moto G 3rd Gen.

Where the Galaxy A3 shines is in its long battery life. We've seen plenty of mid-range smartphones last around 10 hours in our continuous video playback test but the Galaxy A3's 1,900mAh battery lasted an outstanding 14h 37m. That's a good three hours longer than the Moto G 3rd Gen managed.

Another point in the Galaxy A3's favour is its generous 16GB of storage. Only around 10GB is actually available to the user, but that's still a lot more than the usual 8GB (or 5GB once you discount the space taken up by the Android operating system) we usually see in phones at this price.



The 8-megapixel camera is also a cut above what we've seen from other mid-range phones. Colours were rich and vibrant in our outdoor test shots, with plenty of detail. We were able to pick out individual bricks in buildings, for instance, and road signs were legible even from a distance.

We were extremely pleased with the way the camera handled indoor shots in low light too. There was a little noise in shots taken with the lights off, but we could pick out a reasonable level of detail in our still-life, and different textures were clearly defined.

The Galaxy A3 is a great mid-range phone. It's not particularly fast for the price, but we're happy to compromise a little if it means a gorgeous design, an excellent screen, a great camera and a long battery life. The SIM-free price has dropped since its launch, so you have a tough choice between this and the Moto G 3rd Gen. If you want excellent battery life, this is the phone to get, but the Moto G is better value overall.

## SAMSUNG Galaxy S4

★★★★☆

£275 inc VAT • From [www.expansys.com](http://www.expansys.com)

### VERDICT

Now with Android Lollipop, this is a desirable phone despite ageing components

**NEW FLAGSHIP S-SERIES** phones roll off Samsung's production line every year like clockwork. The Galaxy S4 was the 2013 model, and even a couple of years later it looks great.

Although Samsung has since moved to more premium materials for its flagship phones, the Galaxy S4 has a white plastic finish common to the company's older handsets. Look closely and you'll see a fine diamond pattern beneath the gloss surface, which is a nice, subtle touch. The silver trim around the edges looks like metal but is actually plastic. The Galaxy S4 is also surprisingly svelte at just 7.9mm thick and weighs only 130g.

The Galaxy S4 was the first smartphone to use a Full HD AMOLED display. As we'd expect from this type of screen, it has 100% coverage of the sRGB colour gamut and can display pure blacks. We were disappointed with its peak brightness of just 188cd/m<sup>2</sup>, however, which is very low.

The UK version of the Galaxy S4 uses a quad-core 1.9GHz Snapdragon 600 chipset. The phone can handle image-heavy websites

well, showing only occasional stuttering. However, it didn't fare particularly well in our Peacekeeper browser benchmark – its score of 576 places it behind many mid-range handsets such as the Moto G 3rd Gen and Samsung Galaxy A3.

Where the Galaxy S4 eclipses the Moto G 3rd Gen by a considerable margin is in the Geekbench 3 single- and multicore benchmarks, with impressive scores of 690 and 2,246 respectively. This is still behind the similarly priced LG G3, however.

The Galaxy S4 uses an Adreno 320 GPU for graphics. This managed 291 frames (roughly 5fps) in the GFXBench GL offscreen Manhattan test, which is behind the LG G3's 591-frame score. Battery life is another area where it loses out – it lasted 10h 43m in our continuous video playback test, which is two-and-a-half hours shy of the LG G3.

The battery is removable, however, so you have the option of carrying a spare with you. Another feature that has since been removed



from Samsung's more recent flagship handsets is microSD card support. With the Galaxy S4 you can supplement the 16GB of built-in storage with an inexpensive microSD card for your media files.

The Galaxy S4's camera has a 13-megapixel backside-illuminated sensor, and the resulting images are excellent. There was plenty of fine detail to be seen in our still-life tests and exposures were consistently well judged in all light levels. Outdoor shots were excellent – the camera coped well with the strong contrast created by sunshine and produced accurate colours.

The Samsung Galaxy S4 still performs well considering its age, but its plastic build makes it feel dated. It has also held its value surprisingly well, which means the SIM-free option is now expensive for what you get. You're better off buying an LG G3 or a newer handset such as Motorola's Moto X Play for around the same price, or stretching the budget a little for a Sony Xperia Z3 Compact.

## SONY Xperia M2

★★★★☆

£145 inc VAT • From [www.argos.co.uk](http://www.argos.co.uk)

### VERDICT

Great battery life and good build quality, but aged specifications leave it trailing

**THE XPERIA M2** is now over a year old and has been superseded twice, so its price has dropped from its initial £220 to just £145. At this price, however, the M2 is firmly in Moto G 2nd Gen territory, and the M2 hasn't aged nearly as well as Motorola's budget marvel.

The M2's bulky chassis is almost the same size as the Moto G's despite the M2's smaller 4.8in display, making it feel oversized for the amount of screen space available. This is a shame, as the M2's 4.8in display looks reasonably good at first glance, despite its somewhat mediocre 87.7% coverage of the sRGB colour gamut. However, closer inspection reveals a lack of detail in our test images when viewed on the M2 compared with the same images on rival phones.

Areas of shadow were particularly gloomy, and although you can remedy this by increasing the brightness to its maximum level of 410.75cd/m<sup>2</sup>, this makes blacks look quite grey. The display's real downfall is its small 960x540 resolution, however. With a pixel density of 229ppi, the sharpness of the M2's

display pales in comparison with the Moto G 2nd Gen, which has a much higher 294ppi from its 5in screen.

The M2 has been updated to Android 4.4.4 since launch, and Lollipop should be available by the time you read this. When Android 5.1 does eventually arrive, the M2's quad-core 1.2GHz Qualcomm Snapdragon 400 processor should be more than capable of running the OS smoothly.

Its Geekbench 3 scores of 309 in the single-core test and 1,024 in the multicore test are a fraction behind the Moto G's 341 and 1,156, but we saw few signs of stuttering when swiping through the app tray and browsing the various menu settings. The M2 often stumbled when scrolling around web pages with multiple images, however.

Graphics performance was on par with that of the Moto G, as the M2 produced an identical 110 frames in the offscreen Manhattan test in GFXBench GL 3.0. The M2 can't cope with the taxing Hearthstone game,



though, so you'll need to make do with simpler titles.

You'll need to use the microSD card slot if you plan to install lots of apps, as only around 5GB of the phone's 8GB of storage is available to the user. One thing you won't need to worry about is battery life. In our test the M2's 2,330mAh battery lasted 11h 43m, beating the Moto G by two hours.

While we were pleased with the 8-megapixel camera's vibrant colours, every shot we took had blurry edges round certain objects, even when we tapped the screen to focus the camera. This is a shame, as images looked perpetually hazy even in bright lighting conditions. There wasn't a lot of detail either.

The Xperia M2 is well made with great battery life, and its performance just about holds up against the current budget greats. However, its low screen resolution looks particularly outdated and its camera is a bit disappointing. The Moto G 2nd and 3rd Gen are both better buys at this price.

## SONY Xperia M4 Aqua

COMPUTER SHOPPER



RECOMMENDED

£169 inc VAT • From [www.giffgaff.com](http://www.giffgaff.com)

### VERDICT

The camera could be better but the M4 Aqua is well made and has plenty of power

**LIKE THE XPERIA M2** before it, the Xperia M4 Aqua takes several design cues from its Xperia Z cousins, showing that you don't have to put up with overpriced plastic slabs when buying a mid-range smartphone. The result is a seriously stylish-looking handset that's just 7.3mm thick and weighs 136g.

The handset is waterproof, so you can immerse it in up to a metre of water for 30 minutes without damaging it. This has long been a feature of Sony's flagship devices, so it's great to see it being introduced further down the line.

With a 5in, 1,280x720-pixel display, the M4 Aqua has a much bigger screen than the similarly priced Samsung Galaxy A3, but its colour accuracy is disappointing. According to our colour calibrator, the M4 Aqua's display shows just 86.2% of the sRGB colour gamut, which is roughly the same as the £145 Xperia M2 could manage.

Colours might not have a lot of punch, but whites are much cleaner and the screen's high peak brightness of 534.28cd/m<sup>2</sup> makes the

screen easy to see outdoors. The downside is that blacks aren't at all deep – we measured a black level of 0.72cd/m<sup>2</sup>, which is very high indeed.

We were impressed by the M4 Aqua's sheer speed when running Android 5.0. The phone's octa-core Qualcomm Snapdragon 615 processor and 2GB of RAM made it feel like a breath of fresh air compared with other mid-range handsets, such as the Galaxy A3.

The M4 Aqua's Geekbench 3 scores of 638 in the single-core test and 2,427 in the multicore test weren't far off the scores we've seen from some flagship handsets. Equally outstanding was the phone's Peacekeeper browsing test score of 839.

The M4 Aqua has a 13-megapixel camera. We were pleased with how it coped with the bright summer sunshine in outdoor shots. Images were well exposed with only a few areas of blinding white clouds. However, every shot we took in Superior Auto mode produced cool-looking colours, as if a blue



shen covered the entire image. This spoils the photo somewhat, as colours lack vibrancy even in photos taken in blazing sunshine.

The situation didn't improve when we switched to Manual mode and turned on HDR. Exposure levels were once again very impressive, but the pale colour cast was arguably more noticeable than before.

Our only other major grievance with the M4 Aqua is the pitiful amount of onboard storage. Only 4GB of the claimed 8GB is actually available to the user. If you want to store music and video on your phone, you can always upgrade with a microSD card.

The camera may be slightly flawed, but there's still plenty to like about the Sony Xperia M4 Aqua. Its fast processing performance easily outstrips many of its mid-range rivals, and it has the advantage of a classy design and waterproofing. The Samsung Galaxy A3 feels more like a premium handset, though, and has a better screen, making it our choice for a stylish phone.

## SONY Xperia SP



£240 inc VAT • From [www.handtec.co.uk](http://www.handtec.co.uk)

### VERDICT

The Xperia SP feels tough but its design is showing its age

**THE XPERIA SP** launched in 2013, which makes it ancient by smartphone standards (yes, we know it's a silly situation). This is most evident in the phone's chassis, which is a little thick and heavy for a smartphone that has only a 4.6in screen.

The handset's smooth contours make it comfortable to hold and the aluminium frame will withstand knocks. A transparent antenna at the bottom illuminates and flashes different colours to provide notifications at a glance.

The Xperia SP originally launched with Android 4.1, and while it eventually received an update to Android 4.3, that's where it stopped. This phone will never be upgraded to Android 5 Lollipop or 6 Marshmallow, and while that shouldn't be a problem in terms of app compatibility for now, you may find you're frozen out of some Google Play programs in the not-too-distant future.

Inside, it has a dual-core Snapdragon S4 Pro processor running at 1.7GHz, which is also found in the Motorola Moto X. This is supported by 1GB of RAM. The phone still

performs reasonably well. We saw some occasional stuttering when browsing the web, but the phone acquits itself well in general use. This feeling was vindicated by a reasonable Peacekeeper score of 614, which is only a fraction behind a new budget handset like the WileyFox Swift.

Scores of 701 in the Geekbench 3 single-core test and 1,277 in the multicore test are also respectable. When comparing these scores with those of a modern budget smartphone such as the Moto G 3rd Gen, with its quad-core chip, the dual-core SP does very well in the single-core test but, as you'd expect, is eclipsed for multicore performance.

The Xperia SP starts to feel left behind for 3D performance, failing the GFXBench offscreen test completely. The phone lasted 10h 13m in our battery test with the screen set to half brightness, which is below average.

The display is the most disappointing aspect of the Xperia SP when compared with newer handsets. It's reasonably



bright with a peak brightness of 415cd/m<sup>2</sup> but its contrast ratio of 663:1 is disappointing and colours look rather muted. Black levels of 0.62cd/m<sup>2</sup> aren't as deep as we would like, and appear closer to grey. Surprisingly,

its colour accuracy is excellent, with the phone covering 98.9% of the sRGB gamut.

We were disappointed with the Xperia SP's 8-megapixel camera. We liked having a physical shutter button, but while our outdoor shots revealed plenty of detail, colours often looked quite murky, even in shots taken in bright sunshine. We also noticed quite a lot of noise, and clouds in particular were riddled with a light speckling of colour, even in lighter, whiter areas. Indoor shots were better, but the noise persisted and the sensor didn't cope well with low lighting conditions.

The Xperia SP's solid build quality holds up relatively well, but the phone is too expensive for its specification. If you have around £250 to spend, you're far better off with the LG G3.

## SONY Xperia Z3 Compact

COMPUTER SHOPPER  
BEST BUY



£298 inc VAT • From [www.handtec.co.uk](http://www.handtec.co.uk)

### VERDICT

Flagship features in a small handset and an amazing battery life

**WHEN IT LAUNCHED**, the Xperia Z3 Compact impressed us with its high-end specification in a compact body. A year on, it's still an excellent phone and now costs around £50 less than it did when it was brand new.

The 1,280x720 resolution is more than adequate for its 4.6in display. We couldn't see any jagged text or pixelated icons in Sony's modified version of the Android operating system. At launch the Z3 Compact had Android 4.4 installed but it has since been upgraded to Android 5.1.

The screen's colour accuracy is excellent, displaying 96.7% of the sRGB colour gamut according to our colour calibrator. This is exactly what we'd expect to see from a good LCD panel, and the high brightness of 482.58cd/m<sup>2</sup> helps colours pack a punch. We measured the screen's black level as 0.37cd/m<sup>2</sup>, which is nice and deep, leading to a fantastic 1,280:1 contrast ratio.

The Z3 Compact has a 2.5GHz quad-core Qualcomm Snapdragon 801 processor, as found in the LG G3. Despite having the same

processor, the Z3 Compact managed to eclipse the LG G3 in the Peacekeeper browser benchmark with a tremendous score of 906. Web browsing felt much smoother on the Z3 Compact, and we were able to zoom in and pan round image-laden desktop pages with only minimal stutter.

Menus and the Android app tray showed no signs of lag, and Sony's shimmering, twirling ribbon background looks great as you swipe between home screens. The Z3 Compact's performance credentials were further bolstered by scores of 968 and 2,683 in the Geekbench 3 single- and multicore tests.

In our graphics tests, the phone managed 1,579 frames (roughly 25fps) in the GFXBench GL offscreen Manhattan test, making the Z3 Compact perfectly capable of playing even today's most taxing games.

In our continuous video playback test, the Z3 Compact's 2,600mAh battery lasted an unprecedented 20 hours with the screen set to half brightness. With so much staying

power at its disposal, lighter users should easily get two days of life out of it, as Sony estimates, before needing to recharge it.

On the back is Sony's 20.7-megapixel ½.in Exmor RS camera. As with previous Xperia handsets, the Superior Auto mode locks pictures to 8 megapixels, so you'll need to switch to Manual for higher-resolution shots.

Superior Auto mode produced crisp images with more edge detail in each frame and rich colours. More noise was present toward the outer edges when we switched to Manual mode, but there are plenty of options to help you adjust the picture, including ISO, white balance and a slider bar for exposure compensation. The Z3 Compact also has an HDR mode and different scene options if you don't mind shooting at the lower resolution.

The Sony Xperia Z3 Compact truly is a flagship phone in a compact body. It offers fantastic performance, a great screen and incredible battery life, and it puts many more expensive handsets to shame. It's a Best Buy.



## WILEYFOX Swift



£129 inc VAT • From [www.wileyfox.com](http://www.wileyfox.com)

### VERDICT

A great design and a more customisable OS but the screen and camera disappoint

**BRITISH COMPANY WILEYFOX** is looking to usurp Motorola's dominant position in the budget smartphone market by tackling the Moto G head on. The Swift has an almost identical specification, including a 5in, 1,280x720 display, 13-megapixel camera and a quad-core 1.2GHz Qualcomm Snapdragon 410 processor, yet it's slightly cheaper at £129.

Price isn't all that sets the Swift apart, though, as it uses Cyanogen 12.1 rather than plain Android. This Android-based operating system has a number of useful features including more robust privacy controls.

Despite its similarities to the Moto G, the Swift falls behind in several areas, including overall screen quality. The display covers only 79.2% of the sRGB colour gamut, which isn't great even by budget smartphone standards and can't match the 85.4% of the Moto G 3rd Gen. The Swift was weakest when displaying reds, magentas and greens, which left colours looking muted and lacking punch.

Black levels were disappointingly high at 0.57cd/m<sup>2</sup>, which left darker areas of our test

images looking a little grey. A decent peak white level of 551.76cd/m<sup>2</sup> leads to a strong 961:1 contrast ratio, however, so images have plenty of detail.

The Swift's quad-core Qualcomm Snapdragon 410 chipset runs at the standard 1.2GHz rather than the Moto G 3rd Gen's 1.4GHz. This gave the Moto G a clear advantage in our tests, as the Swift scored only 471 and 1,288 in the single- and multicore tests of Geekbench 3, while the Moto G managed 525 and 1,590.

The Swift has 2GB of RAM to the Moto G's 1GB (to get a 2GB Moto G, you have to buy the £189, 16GB Moto Maker model). This gave the Swift a slight advantage when loading apps, as it beat the Moto G repeatedly when we dipped in and out of various programs. There's not much in it, but those who appreciate reduced loading times will find that the Swift leaves you hanging less often.

Web browsing was a more level playing field, despite the Moto G's marginally faster

Peacekeeper score of 731 to the Swift's 639. Scrolling up and down in complex sites such as the *Guardian* produced similar amounts of stutter from each handset, although the Swift was a touch jerkier when zooming in.

Outdoor photos taken with the Swift's 13-megapixel camera were either far too dark, making everything look rather dingy, or too light, resulting in bleached-out skies. Photos were detailed, though, with only the odd sign of grainy noise reduction. HDR mode made photos look unnatural, adding a milky-looking filter across every image. Indoor photos were much better, with natural colours.

The Swift has a lot of attractive features, not least its classy design, interesting OS and 16GB of storage (around 12GB of which is available to the user). However, its screen and battery life are decidedly lacklustre compared with the 3rd Gen Moto G's, and its camera is nowhere near as good, so the Moto G remains our budget choice.

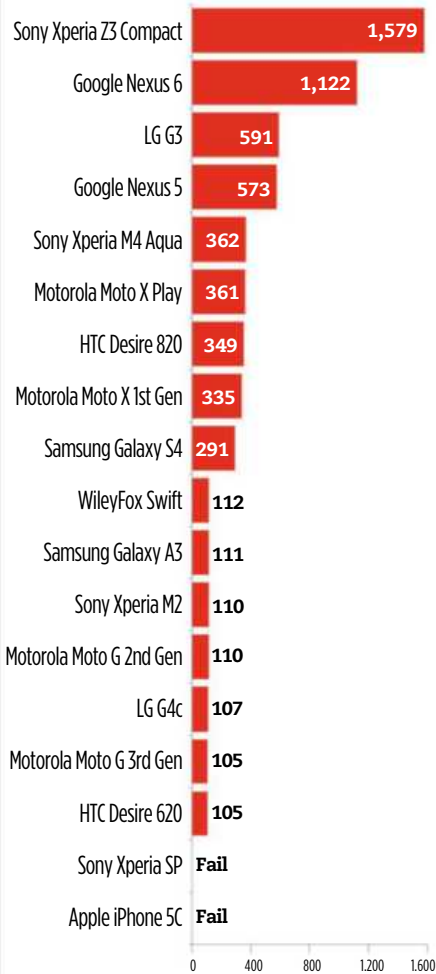




# BENCHMARKS

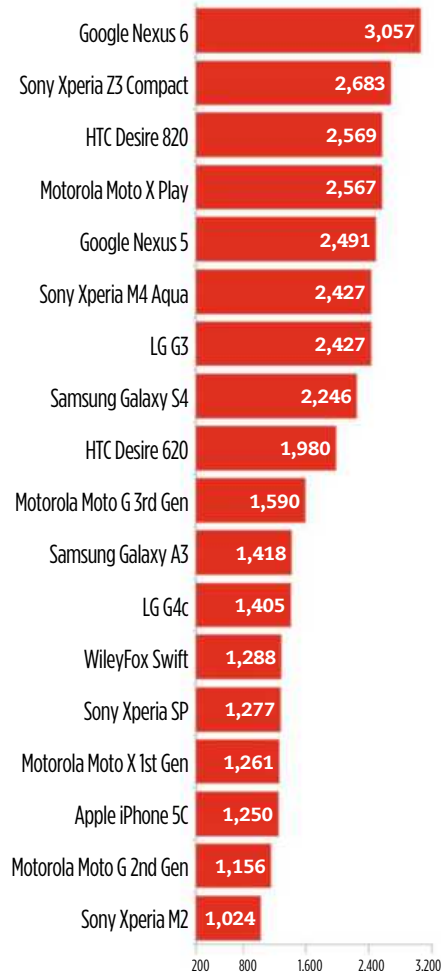
## Performance

**GFxBench GL 3.0 Manhattan Offscreen**



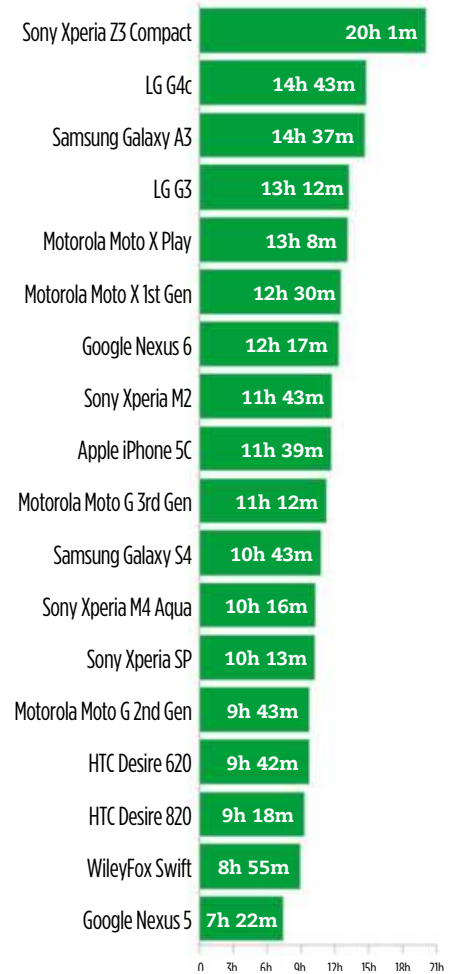
GFxBench Manhattan works across iOS and Android devices (as well as PCs), and is a strenuous test of a device's 3D rendering power. We use the Offscreen test, as it isn't affected by the phone's display resolution.

**Geekbench 3**



Geekbench runs a suite of tests designed to simulate real-world scenarios in order to see how fast your phone really is. It's now optimised to test multicore performance. We print the Geekbench multicore score here.

**Battery life**



Our battery life test plays an H.264 video file on repeat, and records how long it takes to flatten the phone's battery completely from a full charge.

## VERDICT

We've seen plenty of exceptional smartphones this month. From today's mid-range marvels to yesterday's high-flying flagships, you can get fantastic performance and features at great prices. Buy one of these phones SIM-free and get a SIM-only contract and you'll save yourself a considerable chunk of cash compared to taking out a standard 24-month contract.

At the higher end of the budget, the Sony Xperia Z3 Compact is the phone to buy. This has an excellent screen and performance and is a good £100 cheaper than a current flagship handset. If you

want something newer for a similar price, Motorola's Moto X Play is great value, too.

At around the £250 mark, the LG G3 is your best option. Last year's LG flagship is still a top performer and its camera is excellent. It's also around half the price it was at launch, making it a real bargain.

If you want something stylish at a budget price, check out the svelte Samsung Galaxy A3 and the powerful Sony Xperia M4 Aqua. However, the budget champion and Best Buy remains Motorola's Moto G 3rd Gen, which packs in proper performance and an impressive camera at a low price.

### LG G3



### MOTOROLA

Moto G 3rd Gen



### MOTOROLA

Moto X Play



### SAMSUNG

Galaxy A3



### SONY Xperia

M4 Aqua



### SONY Xperia

Z3 Compact



# GET THE BEST DEAL

Buying a phone SIM-free will save you money in the long run, but if you buy an older smartphone, you can take your savings even further. Here we explain how buying one of the older handsets we've reviewed this month will save you a fistful of cash

**THE REASON MANY** of us sign up for 24-month smartphone contracts is to spread the cost of our expensive phone over time. Some new handsets cost almost £800, which is a massive outlay if you buy one SIM-free. Paying £30 a month doesn't seem so bad in comparison, but it adds up over two years.

The smartphones we've reviewed this month prove that you don't have to spend a fortune. There are plenty of new mid-range handsets with excellent specifications and performance, or you can buy an older flagship handset for considerably less than they cost at launch.






Smartphone manufacturers release newer and shinier handsets each year, but smartphones today are so powerful and the market is now so mature that newer devices don't automatically make older ones redundant.

As manufacturers push their new devices, the price of older handsets tumbles dramatically, making it possible to bag a bargain. Often, today's mid-range smartphones have the same chipsets as yesterday's flagships, which means you might pay a premium for a new model when an older flagship performs just as well, if not better.

**READ THE SMALL PRINT**

Not only is the total cost of ownership (TCO) generally higher with a 24-month contract than buying your phone outright, many people end up spending even more on top.

## SIM-only tariffs

NETWORK	MINUTES	TEXTS	DATA	COST PER MONTH
	600	Unlimited	1GB	£14
	2,000	Unlimited	2GB	£20
	500	Unlimited	2GB	£12
	Unlimited	Unlimited	2GB	£20
	Unlimited	Unlimited	2GB	£19

## Smartphones: total cost over two years

		TOTAL COST OF OWNERSHIP (TCO) OVER TWO YEARS				
HANDSET	SIM-FREE PRICE	3	EE	GIFFGAFF	O <sub>2</sub>	VODAFONE
 <b>LG</b> G3	£245	£581	£725	£533	£714	£701
 <b>MOTOROLA</b> Moto G 3rd Gen	£150	£486	£630	£438	£619	£606
 <b>MOTOROLA</b> Moto X Play	£270	£606	£750	£558	£739	£726
 <b>SAMSUNG</b> Galaxy A3	£200	£536	£680	£488	£669	£656
 <b>SONY</b> Xperia M4 Aqua	£169	£505	£649	£457	£638	£625
 <b>SONY</b> Xperia Z3 Compact	£298	£634	£778	£586	£767	£754

This is because many customers fail to renegotiate their contract after the 24-month period is up. As the cost of a handset is incorporated into your monthly bill, you spread the cost over time, so there's a smaller upfront cost for the handset and sometimes no initial cost at all.

The network operators will have made back the cost of your phone by the end of your contract period. Once the handset cost is paid off, the cost to the operator of having you as a customer is considerably less, so your bill should also come down. However, unless you negotiate with your network, you'll carry on paying the high monthly cost, wasting a significant amount of money.

If you buy your phone outright, you can plug in a SIM card from a cheap SIM-free contract and not have to worry about renegotiation – you'll also have the advantage of a 30-day rolling contract, so it's easy to switch to a new provider if you're unhappy with your current one.

### BEST SIM-ONLY DEALS

We list the best price for each handset in the reviews and in the table on page 92. The next step to getting the best deal is to find an appropriate SIM-only contract. In the top table (opposite) we've compared a number of SIM-only tariffs. We've only considered SIM-only deals that give you at least 2GB of data, which is what you need to really make the most of your smartphone, and have a rolling 30-day contract so you're not tied in. The exception is Three, which only has the option of 1GB or 4GB. We've chosen the 1GB tariff for comparison.

The bottom table (opposite) shows what you'll pay in total after two years with each of this month's award-winning handsets, including a SIM-only contract. As you can see, GiffGaff is considerably cheaper than everyone else. It's worth noting that as a mobile virtual network operator (MVNO), GiffGaff actually piggybacks on O2's



Buying an older flagship phone can save you a fortune over two years

network infrastructure, so make sure you have good O2 reception wherever you will be dependent on your phone.

### SELLING YOUR SMARTPHONE

Buying your smartphone outright and opting for a SIM-only contract means you have a great deal more flexibility if you ever decide to sell your smartphone, as you own it outright. Buying an older handset a few years after its release will probably also mean it won't depreciate as sharply as if you bought it when it first came out.

The table below shows how much you can expect to receive for your smartphone from several big trade-in sites. These are current prices, so your phone will probably be worth less in a year's time, but it should give you an idea of how much you can get back should you decide to upgrade. All the prices listed are for unlocked handsets. Phones locked to specific networks fetch less cash. To find the eBay prices we listed all handsets of that type that had been sold at auction (excluding any damaged models) and calculated the average sold price.

## Smartphones: online trade-in value

SMARTPHONE	CURRENT SIM-FREE PRICE	CURRENT TRADE-IN PRICE				
		EBAY	CARPHONE WAREHOUSE TRADE-IN	CEX	O2 RECYCLE	MAZUMA MOBILE
 <b>LG</b> G3	£245	£155	£86	£113	£88	£95
 <b>MOTOROLA</b> Moto G 3rd Gen	£150	£122	£25	£75	£45	£40
 <b>MOTOROLA</b> Moto X Play	£270	£212	Not listed	Not listed	£80	Not listed
 <b>SAMSUNG</b> Galaxy A3	£200	£136	£45	£68	£46	£50
 <b>SONY</b> Xperia M4 Aqua	£169	£122	£27	£87	£30	£30
 <b>SONY</b> Xperia Z3 Compact	£298	£218	£90	£103	£110	£100

	BEST BUY			BEST BUY						
	APPLE	GOOGLE	GOOGLE	HTC	HTC	LG	LG	MOTOROLA	MOTOROLA	BEST BUY
	iPhone 5c	Nexus 5	Nexus 6	Desire 620	Desire 820	G3	G4c	Moto G 2nd Gen	Moto G 3rd Gen	
	★★★★☆	★★★★☆	★★★★☆	★★★★☆	★★★★☆	★★★★☆	★★★★☆	★★★★☆	★★★★☆	★★★★☆
<b>HARDWARE</b>										
Processor	Dual-core 1.3GHz Apple A6	Quad-core 2.3GHz Qualcomm Snapdragon 800	Quad-core 2.7GHz Qualcomm Snapdragon 805	Quad-core 1.2GHz Qualcomm Snapdragon 410	Octa-core 1.7GHz Qualcomm Snapdragon 615	Quad-core 2.5GHz Qualcomm Snapdragon 801	Quad-core 1.2GHz Qualcomm Snapdragon 410	Quad-core 1.2GHz Qualcomm Snapdragon 400	Quad-core 1.4GHz Qualcomm Snapdragon 410	
RAM	1GB	2GB	3GB	1GB	2GB	2GB	1GB	1GB	1GB	1GB
Screen size	4in	5in	6in	5in	5.5in	5.5in	5in	5in	5in	5in
Screen resolution	1,136x640	1,920x1,080	2,560x1,440	1,280x720	1,280x720	2,560x1,440	1,280x720	1,280x720	1,280x720	1,280x720
Screen type	LCD	LCD	AMOLED	LCD	LCD	LCD	LCD	LCD	LCD	LCD
Front camera	1.2 megapixels	1.3 megapixels	2 megapixels	5 megapixels	8 megapixels	2.1 megapixels	5 megapixels	2 megapixels	5 megapixels	5 megapixels
Rear camera	8 megapixels	8 megapixels	13 megapixels	8 megapixels	13 megapixels	13 megapixels	8 megapixels	8 megapixels	13 megapixels	13 megapixels
Flash	LED	LED	Dual LED ring flash	LED	LED	LED	LED	Yes	Dual LED	Dual LED
GPS	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Compass	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Storage	8GB	16GB	32GB	8GB	16GB	16GB	8GB	8GB	8GB	8GB
Memory card slot	None	None	None	MicroSD	MicroSD	MicroSD	MicroSD	MicroSD	MicroSD	MicroSD
Wi-Fi	802.11n	802.11ac	802.11ac	802.11n	802.11n	802.11ac	802.11n	802.11n	802.11n	802.11n
Bluetooth version	4	4	4.1	4	4	4	4.1	4	4	4
NFC	No	Yes	Yes	No	No	Yes	No	No	No	No
Wireless data	3G, 4G	3G, 4G	3G, 4G	3G, 4G	3G, 4G	3G, 4G	3G, 4G	3G, 4G	3G, 4G	3G, 4G
Dimensions	124x59x9mm	138x69x8.6mm	159x83x10.1mm	150x73x9.6mm	158x79x7.7mm	146x74x8.9mm	140x70x10.2mm	141x70x11mm	142x72x6.1mm	142x72x6.1mm
Weight	132g	130g	184g	160g	155g	149g	136g	149g	155g	155g
<b>FEATURES</b>										
Operating system	iOS 9.1	Android 6.0	Android 6.0	Android 4.4.4	Android 4.4.4	Android 5.0.1	Android 5.0.2	Android 4.4.4	Android 5.1.1	Android 5.1.1
Battery size	1,510mAh	2,300mAh	3,220mAh	2,100mAh	2,600mAh	3,000mAh	2,540mAh	2,070mAh	2,470mAh	2,470mAh
<b>BUYING INFORMATION</b>										
Warranty	One year RTB	One year RTB	One year RTB	One year RTB	One year RTB	One year RTB	One year RTB	One year RTB	One year RTB	One year RTB
Price SIM-free (inc VAT)	£200 (refurbished)	£189 (refurbished)	£295	£161	£220	£245	£210	£135	£150	£150
Price on contract (inc VAT)	N/A	N/A	Free on £37.50-per-month contract	Free on £20-per-month contract	N/A	N/A	Free on £20-per-month contract	N/A	Free on £21-per-month contract	Free on £21-per-month contract
SIM-free supplier	www.refurb-phone.com	www.google.co.uk/nexus/5	www.expansys.com	www.expansys.com	www.mobilephonesdirect.co.uk	www.buyer.com	www.expansys.com	www.buyer.com	www.carphonewarehouse.com	www.carphonewarehouse.com
Contract/prepay supplier	N/A	N/A	www.carphonewarehouse.com	www.three.co.uk	N/A	N/A	www.carphonewarehouse.com	N/A	www.carphonewarehouse.com	www.carphonewarehouse.com
Details	www.apple.com/uk	www.photodeirect.co.uk	store.google.com/product/nexus_6	www.htccom/uk	www.htccom/uk	www.lg.com/uk	www.lg.com/uk	www.motorola.co.uk	www.motorola.co.uk	www.motorola.co.uk
Part code	iPhone 5c	DB821	XT1100	Desire 620	Desire 820	LG G3 D855	LG H525N	XT1068	XT1541	XT1541

	BEST BUY		RECOMMENDED		BEST BUY	
	MOTOROLA	MOTOROLA	SAMSUNG	SONY	SONY	WILEYFOX
	Moto X 1st Gen	Moto X Play	Galaxy S4	Xperia M2	Xperia SP	Xperia Z3 Compact
	★★★★☆	★★★★★	★★★★☆	★★★★☆	★★★★☆	★★★★★
<b>HARDWARE</b>						
Processor	Dual-core 1.7GHz Qualcomm Snapdragon S4 Pro	Quad-core 1.2GHz Qualcomm Snapdragon 410	Quad-core 1.9GHz Qualcomm Snapdragon 600	Quad-core 1.2GHz Qualcomm Snapdragon 400	Dual-core 1.7GHz Qualcomm Snapdragon S4 Pro	Quad-core 2.5GHz Qualcomm Snapdragon 410
RAM	2GB	1.5GB	2GB	1GB	1GB	2GB
Screen size	4.7in	4.5in	5in	4.8in	4.6in	5in
Screen resolution	1,280x720	960x540	1,920x1,080	960x540	1,280x720	1,280x720
Screen type	AMOLED	AMOLED	AMOLED	LCD	LCD	LCD
Front camera	2 megapixels	5 megapixels	2 megapixels	0.3 megapixels	0.3 megapixels	5 megapixels
Rear camera	10 megapixels	8 megapixels	13 megapixels	8 megapixels	8 megapixels	13 megapixels
Flash	LED	LED	LED	LED	LED	LED
GPS	Yes	Yes	Yes	Yes	Yes	Yes
Compass	Yes	Yes	Yes	Yes	Yes	Yes
Storage	16GB	16GB	16GB	8GB	8GB	16GB
Memory card slot	None	MicroSD	MicroSD	MicroSD	MicroSD	MicroSD
Wi-Fi	802.11ac	802.11n	802.11ac	802.11n	802.11n	802.11n
Bluetooth version	4	4	4	4	4	4
NFC	No	Yes	Yes	Yes	Yes	No
Wireless data	3G, 4G	3G, 4G	3G, 4G	3G, 4G	3G, 4G	3G, 4G
Dimensions	129x65x10.4mm	130x65.6.9mm	136x70x7.9mm	140x71x8.6mm	131x67x10mm	141x72x9.4mm
Weight	130g	110g	130g	148g	155g	135g
<b>FEATURES</b>						
Operating system	Android 5.1.1	Android 5.0.2	Android 5.0.1	Android 4.3	Android 4.3	Android 5.1.1
Battery size	2,200mAh	1,900mAh	2,600mAh	2,330mAh	2,370mAh	2,600mAh
<b>BUYING INFORMATION</b>						
Warranty	One year RTB	One year RTB	One year RTB	One year RTB	One year RTB	One year RTB
Price SIM-free (inc VAT)	£195	£200	£275	£145	£240	£298
Price on contract (inc VAT)	N/A	Free on £22-per-month contract	N/A	N/A	N/A	Free on £22-per-month contract
SIM-free supplier	www.handtec.co.uk	www.expansys.com	www.expansys.com	www.argos.co.uk	www.handtec.co.uk	www.wileyfox.com
Contract/prepay supplier	N/A	www.carphonewarehouse.com	N/A	N/A	N/A	www.carphonewarehouse.com
Details	www.motorola.co.uk	www.samsung.com/uk	www.samsung.com/uk	www.sony.co.uk	www.sony.co.uk	www.sony.co.uk
Part code	XT1052	SM-A300FU	GT-19505	D2303	C5306	Sony D5803

Prices correct at time of going to press



# MEDIA STREAMERS

## Big-screen entertainment

There's no need to crowd around a laptop or fork out for a new smart TV – media streamers are a great way to bring entertainment to the living room. We pit the four most popular streamers against each other

**VIDEO-ON-DEMAND** and catch-up services have completely changed the way we watch films and TV programmes. No longer are we at the mercy of programme schedulers – so much so that getting home in time to watch your favourite show sounds an antiquated concept. Similarly, we don't need to deal with physical media taking up space and requiring a trip down the shops to get hold of the latest release – these days, it's usually a few taps or clicks away.

Instead, through services such as BBC iPlayer and Netflix, we have all become the scheduler, deciding what we want to watch, when we want to watch it. While in the past you might have had to resort to watching content on your laptop or tablet, now – thanks to the advent of media-streaming devices – it's easier than ever to get the content to your television set.

### LITTLE BOX OF TRICKS

Media streamers come in tiny little packages, ranging from around the size of a few stacked CDs to tiny little sticks no bigger than a flash drive. These are designed to be plugged directly into your television's HDMI input and are hidden away. Gone are the days of unsightly PVRs and set-top boxes taking up space in your AV cabinet.

### MAKING A CONNECTION

As media streamers are designed for streaming content from the internet, they

need to be connected to your router. The bigger streamers will often come with an Ethernet connection, which will translate to better throughput speeds, but you'll usually also have the option of using a wireless connection. Because of the small size of the streaming sticks, these are limited to Wi-Fi connections, but all the models we tested here are dual-band, which means you can use the 5GHz network for better performance.

### REMOTE WORKING

All but the Chromecast we tested this month come with a companion remote control for navigating content and changing settings. Some of the remotes also have microphones, so you can search for content to watch without having to type in requests.

The Chromecast requires you to use your smartphone, tablet or desktop browser to control it. Most streaming devices do have companion apps available, however, so there are multiple ways to interact.

### CAST OFF

With the Google Chromecast, you get content to your Chromecast by 'casting' compatible apps through the device. The Chromecast essentially acts as a bridge between a smartphone and the content. However, the Chromecast itself connects to the relevant media source, such as YouTube, then outputs to your television, rather than streaming content from the device in your hand.

Other streaming devices, such as the Amazon Fire TV Stick and Roku Streaming Stick, can also be used in a similar, but not identical way, through something called the DIAL (Discovery and Launch) protocol. The compatible list of services isn't as exhaustive as Chromecast's, however, but Netflix and YouTube are the two stand-out apps to support DIAL technology.

### SERVICE CHARGE

With a multitude of video-on-demand and catch-up services available, there's unfortunately still yet to be one device that can take on streaming responsibilities for every service. This means that while Amazon Instant Video might be available on one device, it may not be on another. Similarly, Netflix isn't available everywhere, which is annoying but an unfortunate reality. Fortunately, at least when it comes to catch-up services for the UK's terrestrial channels, these are now better supported across most of the players we tested.

### SERVING UP CONTENT

Through DLNA support, many of the streamers we tested will allow you to access your own content to watch on the big screen. Many of them also support Plex servers, which is a great way to access content on a networked PC or NAS and will even transcode videos into a format your media streamer can support.

# AMAZON Fire TV Stick

COMPUTER SHOPPER ★★★★★

RECOMMENDED £35 inc VAT • From www.amazon.co.uk

## VERDICT

The Amazon Fire TV Stick excels if you're an Amazon Prime subscriber

**THE FIRE TV** Stick is a media streamer no larger than a USB flash drive. It has an HDMI connection on one end to plug into your TV, and a Micro USB port on the other for power. If your TV's USB ports are powerful enough, you can use them to power the Fire TV Stick; however, you won't be able to update the device's firmware. We therefore recommend you use the supplied USB power adaptor.

An HDMI extender is also included, which could be useful if your TV's HDMI ports are packed closely together. The Fire TV Stick is capable of up to 7.1 channel audio and outputs a 1080p image, so you may want to plug it into an AV receiver to get full surround sound.

The Fire TV Stick includes a dedicated remote control in the box. It has all the media

The Fire TV Stick uses Amazon's Advanced Streaming and Prediction (ASAP) feature, which is supposed to predict content you're likely to watch, buffering it in the background. It worked fairly well in our testing, beginning shows we'd watched previous episodes of almost instantly rather than after a few seconds. Even when it hadn't pre-buffered, though, we didn't have to wait long to play content.

ASAP doesn't tend to kick in as often when you flit between different films or shows as it does when watching consecutive episodes of the same TV series. It does at least pre-buffer content if you spend a few



Finally, you can play your own content using apps such as Plex. You also get access to Plex Cloud Sync servers through the dedicated Plex for Fire TV app, which isn't always available through every version of Plex. DLNA servers and AirPlay streaming are technically supported using third-party apps such as AirPlay/DLNA Receiver, although we had issues trying to stream Full HD content from an iPhone over a wireless network, resulting in broken and distorted video.

The basic Amazon Fire TV Stick is great value at £35, and £10 extra for the advanced functionality of the Voice Remote is reasonable, too. It doesn't quite emulate all the Chromecast's functionality, but given its excellent built-in app support that may not be important. Even if you're not an Amazon Instant Video subscriber the low cost makes it an enticing prospect for streaming local content such through apps such as Plex.

The interface is mostly quick and responsive, save for the occasional slow app load, and the physical remote control adds an extra degree of convenience over Chromecast. You still have the option of using a smartphone or tablet as a remote as well.

In the end, the Roku Streaming Stick remains our favourite discrete streaming stick thanks to its similarly low price, great functionality and full roster of catch-up services, but if you're an Amazon Prime subscriber the Fire TV Stick is your best bet.

## Amazon's Advanced Streaming and Prediction feature is supposed to predict content you're likely to watch

and navigation controls you would expect, is well built and delightfully compact. There are two versions of the Fire TV Stick available, as it can also be bought with a Voice Remote for an extra £10. This allows you to speak commands or conduct voice searches to find new content quickly and easily. You can search for video content in the Amazon Instant Video app and Amazon's app store, but voice search doesn't work in other apps. For Amazon content, voice search is very accurate and certainly a lot quicker and easier than using the onscreen keyboard.

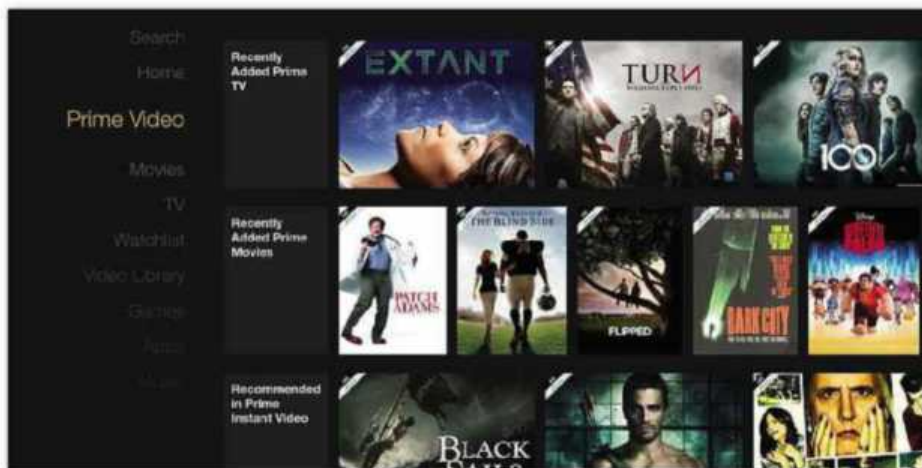
If you opt for the cheaper Fire TV Stick without the Voice Remote and want the missing voice search functionality, you can install the free Fire TV Remote App for iOS or Android. This emulates the physical remote control's inputs and gives you voice search as well. Rather than having directional controls, as on the physical remote, you use swipe and tap motions to navigate on an onscreen touchpad, which works well. You can also use your connected device's keyboard, which is much better than using the physical remote to enter text.

The Fire TV Stick interface has a vertical list of icons that branches into a horizontal carousel of tiles based on different categories, such as Movies and Music. Unsurprisingly, Amazon's Instant Video service gets prime placement. Instant Video is a major part of Amazon's Prime service, which costs £79 per year and includes free next-day delivery on Amazon purchases, among other perks. It's also available by itself for £5.99 a month.

seconds reading a programme or movie description, which is handy if you often can't decide what to watch.

Access to Amazon's App Store means you can add extra on-demand and catch-up services to the Fire TV Stick's homescreen. A lot of big-name apps are available, including Spotify Connect for music streaming, YouTube for watching videos, Sky News and BBC Sport. You can also download games and play them using your remote or the optional Fire TV games controller (£40 from Amazon).

Where it comes to catch-up TV, Amazon's Fire TV Stick is now better supported than at launch. It recently added ITV Player, but All 4 is still missing, which is a shame. Otherwise, there's BBC iPlayer and Demand 5. There's also Netflix if you're a subscriber.



# GOOGLE Chromecast (2015)



£30 inc VAT • From [www.google.com/chromecast](http://www.google.com/chromecast)

## VERDICT

The new Google Chromecast remains a cheap way to add smart functionality to your TV

**WHEN THE GOOGLE** Chromecast was first released, it was the cheapest and easiest way to give your TV a smart boost. At £30 it was an enticing device that made getting content to your big screen a breeze. Google's new Chromecast comes in a slightly different form factor with improved networking performance thanks to 802.11ac Wi-Fi support. While the networking upgrades are welcome, there are now rival streaming sticks that work in a similar way and offer additional functionality.

As the small dongle doesn't require lots of messy cables and is controlled via Wi-Fi, the Chromecast can be tucked neatly out of view. Setup couldn't be easier: just plug the HDMI connector into a spare port on the back of your TV and the USB power cable into the 'puck'. The new Chromecast makes this even easier thanks to its flexible HDMI cable.

The original's slightly bulbous design meant it could be tricky if your HDMI ports were close together. The new design is far more elegant and the HDMI cable clips to the back using a magnet, making the whole assembly resemble a key fob.

Power is delivered through a Micro USB port and this can be done through your TV's USB ports if available for a more elegant installation. Any USB port that's powerful enough will do the trick, so you can use one on an AV amp or set-top box if you want to keep the cabling neat and don't want yet another power adaptor at the back of your telly. A USB power adaptor is included for those that don't have any other option.

Initially, setting up the Chromecast is a matter of downloading the Chromecast app (iOS and Android) and then joining your tablet or smartphone to the Chromecast's local Wi-Fi network. Once connected, you use

the app to join the Chromecast to your proper Wi-Fi network.

The new Chromecast supports 802.11ac 5GHz networks and has an adaptive antenna for improved networking performance. Where the original could struggle when streaming local content from a NAS through Plex, this isn't an issue with the newer Chromecast. If you don't have an 802.11ac or 5GHz network, the Chromecast can connect to a regular 802.11n 2.4GHz network, although performance will be similar to the original Chromecast.

The Chromecast app has been improved as well. Where previously it was just used to connect the Chromecast to your wireless network and for screen mirroring, the new version is more of a hub to find and access apps that support the Chromecast protocol for getting content to your big screen.

The way in which you get content to a Chromecast is through supported apps. From the app, you simply tap the Chromecast button, select the Chromecast device you want to use and the content is beamed from your smartphone or tablet to play on your TV. For most content, it's important to remember that you're not actually streaming from the control device to the Chromecast.

Instead, your controlling device talks to the Chromecast and tells it where it can access the stream from; the Chromecast then takes over playback duties, letting you use your PC, smartphone or tablet for any other job. However, a connection is still kept between the two devices, so that you can control playback. Start a Netflix film or TV show from your smartphone, for example, and

you can pause, fast-forward and rewind using the touchscreen or onscreen controls.

If you want to use your Chromecast to watch online movies, the two best options at the moment are Netflix and Google Play Movies. There is also now support for Wuaki.tv and Blinkbox. Unfortunately, there's no support from Amazon Instant Video, even though this now has an Android app.

The Chromecast falls short when it comes to support for catch-up TV. The Android BBC iPlayer app supports Chromecast and works wonderfully, but there's no support for ITV Player, All 4 or Demand 5. There is at least the option of using Sky's Now TV app if you subscribe to any of its packages.

The best way to get your own video content to your television through a Chromecast is to use Plex, which you can run on either a network server or a computer. Its limited codec support, however, means you might need to transcode your videos into a format the Chromecast can support.

Chromecast isn't just about video, although that's clearly its primary purpose. In fact, any supported app can be cast to your TV, letting you send photos, audio and even the full onscreen app, interface and all. Google also wants Chromecast be a home for games and other entertainment.

The Big Web Quiz for Chromecast is a perfect example of this in action: up to six players with the app can take part in an interactive quiz that uses Google's Knowledge Graph, with the results and questions appearing on your TV. It's great fun and easy to set up, and shows how flexible Chromecast really is. There are other games available on the Google Play Store and Apple App Store, and the range is bound to expand soon.

At just £30, Google's Chromecast would appear to be a no-brainer, but it's not quite that simple. Although it has become a lot better, there's still not a lot of support for catch-up TV beyond the BBC's iPlayer. Some may find having to use a smartphone or tablet to control content tiresome and will prefer to have a dedicated remote control and onscreen interface, too.

If you care more about flexibility and easier access to more advanced functions such as DLNA servers, you'll be better off with the Roku Streaming Stick. If you have Android (or a mix of Android and iOS) devices and simply want a cheap and convenient way of adding some streaming services to your TV, then the Chromecast is a solid choice.





# ROKU Streaming Stick

COMPUTER SHOPPER  
BEST BUY



£39 inc VAT • From www.currys.co.uk

## VERDICT

A great media streamer at a reasonable price with plenty of content

**AFTER THE SUCCESS** of the Chromecast, it's no wonder that Roku decided to have a go at the same market with its Streaming Stick. As with the first Chromecast, this media streamer looks like a USB flash drive, but its HDMI port plugs directly into your TV.

It's a little slimmer than the Chromecast, so it shouldn't obscure any of your TV's other HDMI ports. Sadly, unlike the Chromecast, the Streaming Stick doesn't come with an HDMI extension cable if it does get in the way.

The Streaming Stick is powered by USB, so you should be able to plug the supplied Micro USB cable into a spare port on your TV. If you don't have one, or you find that your TV's ports don't provide enough power, there's a 1A USB mains power adaptor in the box.

That's as far as the comparisons go with the Chromecast, as the Streaming Stick doesn't require you to send content to it from a smartphone or tablet, but runs its own self-contained apps and operating system. One advantage of this system is that the Streaming Stick is easier to set up and configure, as you do everything onscreen using the bundled remote control.

It's a basic remote, with a cursor pad, home, back, OK and playback controls, but that suits the Streaming Stick's simple interface. Sadly the remote doesn't have the headphone port of the Roku 3's remote, which was great for watching late-night TV.

Your first job is to set up the Streaming Stick. You'll have to wait a while for it to start up. If powered from your TV, every time you turn your TV off at the mains or use its physical power button, you'll have a bit of a wait when you want to use the Streaming Stick, which is a little annoying.

The first time it powers up, you log into your Roku account (you can create one for free

if you don't have one) and join the device to your home network. It has an 802.11n Wi-Fi adaptor and supports both 2.4GHz and 5GHz networks.

Once you've got the Streaming Stick on your network, you can use the Remote for Roku app for Android or iOS. These have the advantage that you can use your phone's software keyboard to enter text, which is faster than using the Streaming Stick's onscreen keyboard via the remote control.

Anyone familiar with Roku's other media streamers will be immediately at home here, as the Streaming Stick has exactly the same interface. A large tiled homescreen shows you the apps (called Channels) you've installed. New Channels can be added through the Channel Store. It's split into categories, but there's no way to search for a specific app, which can make finding a Channel rather laborious, especially when there are over 450 to search for. Not all Channels are free, which is why you have to provide your credit card details when you create your Roku account.

Unfortunately, we found the Streaming Stick a little sluggish when navigating between screens, with occasional slow transitions and animations. Some channels were also slow to start. This is a real shame, as one of the best things about regular Roku streamers is their speed and responsiveness. Fortunately, the breadth of content available makes up for any slight shortcomings with the interface.

Roku supports all the major services, including BBC iPlayer, ITV Player, All 4 and Demand Five. You also get a free Sky News app, while Now TV gives you subscription options to watch the best from Sky, including Sky Atlantic, Movies and Sports. This is a long way ahead of the streamer's rivals.



There's also a range of other film channels available, including the aforementioned Sky Now TV, as well as some smaller ones providing access to free films, such as Flixter, which lets you buy and rent a decent range of films. There are some smaller, slightly wackier choices, too, such as Kung-Fu Theatre. Content and quality is quite variable, but you can try out the options to see if there's something to match what you like.

It's good to see that the Streaming Stick supports surround sound from those services that provide it, such as Netflix. To get this option working you have to first enable it in the Settings menu. You'll also need to plug the Streaming Stick directly into a spare HDMI port on your AV amp.

Through the Roku Media Player you can access DLNA media servers on your home network, which you'll probably have built into a NAS device. It's a simple, but quick app. One issue is that, like the Chromecast, the Streaming Stick doesn't support many video formats. H.264 is the main video codec, with MKV, MP4 and MOV files all supported. If you don't have content in any of these formats, you'll need to convert your videos to play. Photo and music support is better with all of the major formats supported.

Unfortunately, the Streaming Stick is not a DLNA renderer, which means that you can't beam content to it from a smartphone, tablet or PC. Alternatively, there's a Plex app available, which will connect to a Plex server on your home network. The beauty of this system is that the Plex server can transcode video on the fly, converting it into a format that the Streaming Stick can play. (See *Shopper 321* for our guide on how to set up and use a Plex server.)

There's also web-based content from services such as YouTube, Dailymotion and Livestream, and a good selection of music through Vevo, Spotify and TuneIn Radio, among others. Other more obscure channels are also available, so whatever your interests, from video games to cookery, the selection from Roku is sure to have you covered.

The price of the Roku Streaming Stick has come down significantly since its launch and you can now pick one up for a reasonable £39 from Currys. This also includes three months of Sky Now's Entertainment package, making it incredible value and worthy of our Best Buy award.



# SKY Now TV

COMPUTER SHOPPER ★★★★★

RECOMMENDED £15 inc VAT • From www.nowtv.com

## VERDICT

The Now TV is a great little box that provides plenty of content at reasonable prices

**IF YOU ALWAYS** wanted Sky TV but were put off by the high prices and the need to install a satellite dish and Sky+ box in your home, then Sky's Now TV service may be just the thing. In direct competition with the likes of Netflix and Amazon Instant Video, Sky's TV service provides top-quality films and TV shows via your internet connection.

The content itself is broadly split into Sports, Movies and Entertainment, which largely mirror Sky's satellite offerings of Sky Sports, Sky Movies and many of the usual entertainment channels you'd expect from a pay-TV package. How you pay for these is very different, though, with all three available individually, rather than in complex bundle deals, and you can cancel and restart each service as you wish.

Alongside support for the Now TV app from various smart televisions, games consoles and on desktops and laptops, Sky has its own inexpensive dedicated box. The new, faster version is still astoundingly cheap at just £15, plus you can buy a bundle with discounted Now TV content thrown in for £25, saving up to 31% on the usual prices.

The Now TV box also comes with free content and features, including iPlayer and the other main UK catch-up TV services. In fact, for some, it's worth buying even if you never use a single Now TV service. It's a good and cheap way of upgrading an older TV with basic smart TV features (presuming it at least has an HDMI input).

Compared to the labyrinthine pricing structures of Sky's 'triple-play' TV, broadband and telephone packages, Now TV is refreshingly simple, and pretty competitive too. The Entertainment Pass costs £6.99 a



month, and the Sky Movies Pass costs £9.99 a month. Sports is still Sky's jewel in the crown, though, with prices to match, although those higher prices are offset somewhat by a variety of options. There's a Sky Sports day pass costing £6.99 a day, a weekly pass for £10.99, or a monthly pass for £32 a month.

As for the Now TV box itself, it fits in the palm of your hand, has an HDMI output to connect to your TV and uses either an Ethernet cable or Wi-Fi to connect to your

It comes with a dinky black IR remote, which has few buttons but still does everything you need. The buttons are all clearly labelled and, although rubbery, have a nice distinct click as you push them in, so you know you've pressed them. The interface responds practically instantly to your inputs, making the whole thing a joy to use.

The interface here is similar to that on all Roku boxes: there's a simple text menu down the left and then content is provided in a tiled

## Content is broadly split into Entertainment, Sports and Movies, which largely mirror Sky's satellite offerings of Sky Sports, Sky Movies and the usual entertainment channels

broadband router. There's a USB port, from which you can play the most common video, audio and image formats. Power is provided by a small plug adaptor, and there's even an HDMI cable in the box.

The device itself is actually a rebranded Roku media streamer, with a minimal menu system that lets you get to everything almost instantly. From the homescreen you can launch pretty much all the apps you're ever likely to need, including UK catch-up TV services and Now TV.

menu on the right, going full-screen as you navigate across from the menu to the content you want. It's all simple, transparent and straightforward. It keeps track of what you've watched so you can quickly find the next episode.

The big selling point has to be the inclusion of BBC iPlayer, ITV Player, All 4 and Demand 5 catch-up services, which is mighty impressive for a £15 box. It uses the latest version of the iPlayer menu, with seven days of catch-up, HD content and the option to start watching live shows from the beginning if you come in halfway through.

All the apps load quickly, and getting back to the main menu is just a button press away. There's no UPnP server app for streaming media from elsewhere in your home unless you jump through a number of hoops, though, and no support for competing services from Netflix or Amazon.

At this price it's hard to complain at such omissions. If you're looking for catch-up TV on the cheap this is a great buy, but it's not a replacement for a fully fledged Roku for those wanting to stream a variety of content. The Now TV box may have its limitations but as a simple way to add content to an ageing TV it's a decent choice. If you want a more fully featured media streamer, the Roku Streaming Stick has support for Now TV as well as a wealth of other services such as Netflix.



RECOMMENDED		BEST BUY	RECOMMENDED
<b>AMAZON</b>	<b>GOOGLE</b>	<b>ROKU</b>	<b>SKY</b>
Fire TV Stick	Chromecast (2015)	Streaming Stick	Now TV
★★★★★	★★★★☆	★★★★★	★★★★☆

**HARDWARE**

Audio inputs	None	None	None	None
Audio outputs	None	None	None	None
Video outputs	HDMI	HDMI	HDMI	HDMI
Dock connector	None	None	None	None
USB port	None	None	None	1x USB2
Storage	None	None	None	None
Networking	802.11n (dual band)	802.11ac (dual band)	802.11n (dual band)	802.11n (dual band), Ethernet
NFC	None	None	None	None
App support	Android, iOS	Android, iOS	Android, iOS	Android, iOS
Dimensions	14x41x119mm	51.9x51.9x13.9mm	78x28x12mm	84x84x23mm
Weight	56.9g	34g	23g	100g

**STREAMING**

Streaming formats	DLNA, Plex	Chromecast	DLNA, Plex	None
Supported servers	DLNA, Plex	DLNA, Plex	DLNA, Plex	None
Audio formats	AAC, AC-3, E-AC-3, HE-A, PCM, MP3	MP3, AAC, Ogg Vorbis, Wav	AAC, MP3, WMA, FLAC, WAV	None
Video formats	H.263, H.264, MPEG4-SP, VC-1	H.264	H.264, VC-1	None
Video file extensions	MP4, 3GPP, AVC	None	MKV, MP4, MOV, WMV	None
Image formats	JPEG, PNG	BMP, GIF, JPEG, PNG	JPG, PNG, GIF	None
Internet streaming services	BBC iPlayer, ITV Player, Netflix, Amazon Instant Video, Spotify, Plex, YouTube	BBC iPlayer, Netflix, Sky Now TV, Google Play Movies & TV, Spotify, Plex, YouTube	BBC iPlayer, ITV Player, All 4, Demand Five, Netflix, Sky Now TV, Google Play Movies & TV, Spotify, Plex, YouTube	BBC iPlayer, ITV Player, All 4, Demand 5, Sky Now TV, Spotify, YouTube

**BUYING INFORMATION**

Price including VAT	£35	£30	£39	£15
Warranty	One year RTB	One year RTB	One year RTB	One year RTB
Supplier	www.amazon.co.uk	www.google.com/chromecast	www.currys.co.uk	www.nowtv.com
Details	www.amazon.co.uk	www.google.com/chromecast	www.roku.com	www.nowtv.com
Part code	Fire TV Stick	GA3A00094-A04-Z01	3500EU	2400SK

Prices correct at time of going to press


**VERDICT**

With such inexpensive media-streaming devices available, there's no reason to make do with a non-internet connected television in this day and age. There's certainly no reason why your content should be confined to a small screen, anyway. Unfortunately, though, there's no streaming device that ticks all the boxes.

The truth is that everyone's needs are different, so look at the compatibility table above to see where your needs are met.

All the streaming devices we tested have their own strengths and weaknesses, but the best supported is the Roku Streaming Stick, which is not only very well supported but is also great value. The only

major omission is Amazon Instant Video, which is slightly annoying as the Amazon service is available on Roku devices in the US but not the UK.

At the other end of the scale, if you only have the most basic needs and want to get catch-up services on your television, the Sky Now TV is an inexpensive upgrade. 

**AMAZON**  
Fire TV Stick

★★★★★

**COMPUTER SHOPPER**  
RECOMMENDED



**ROKU**  
Streaming Stick

★★★★★

**COMPUTER SHOPPER**  
BEST BUY



**SKY**  
Now TV

★★★★★

**COMPUTER SHOPPER**  
RECOMMENDED





# IS THE **INTERNET** **KILLING** THE **PLANET?**

How much damage is our increasing reliance on technology doing to the environment? And could the internet actually help to cut carbon emissions? **Mike Bedford** investigates

**A**ccording to conventional wisdom, electronic devices such as PCs and smartphones consume less energy than equipment such as washing machines and cookers, which in turn are less demanding than vehicles such as cars and aircraft. This simplistic analysis suggests the environment has little to fear from computers and, as you'd expect, statistics demonstrate how dramatic the differences can be.

Figures released by the Emirates airline, the world's biggest international carrier, show that its Airbus A380 super-jumbos, while being greener than most passenger aircraft, emit 75g of carbon dioxide per passenger-kilometre. If we bear in mind that one of these aircraft can transport 517 passengers, and takes about seven hours to cover the 5,500km between London and Dubai, this works out at 30 tonnes of carbon dioxide per hour.





A typical smartphone, on the other hand, lasts a day on a full charge with average use. Its battery has a capacity of 2,000mAh at 3.7V, which equates to 7.2Wh. Given that generating electricity in the UK produces, on average, 500 grams of carbon dioxide per kWh, a phone is responsible for 0.15g of carbon dioxide per hour, or approximately 200 millionths of the emissions of the A380.

None of this is in the least bit surprising, but we're forgetting one important fact: volumes. There are currently around 4,000 wide-bodied (twin-aisled) passenger jets in service, a figure that pales into insignificance compared to an estimated two billion smartphones, a similar number of power-hungry laptop and desktop PCs, and the hundreds of thousands of data centres that power the internet to which they're attached.

Indeed, some pundits have questioned whether the internet is environmentally sustainable, given its continuing huge rate of growth. With a recent prediction that the internet could consume the whole of the UK's electricity by 2035, we thought it was high time to weigh up the evidence.

## The state of play

To set the ball rolling, we wanted to get a feel for the state of play today and, in particular, just how much energy is being consumed by the internet. Given that we read a lot of sensational pseudo-scientific statistics on this subject – such as ‘did you know two Google searches uses as much energy as boiling a kettle for a cup of tea?’ – we were keen to talk to someone with a clearer view of things.

Jonathan Koomey, a research fellow at the Steyer-Taylor Center for Energy Policy and Finance at Stanford University, has been working on the energy used by information technology for more than two decades.

## THE BRAZILIAN ENIGMA

Back in 2006, calculations revealed that an avatar in the online game Second Life used as much energy as a person living in Brazil. This analysis drew much criticism, mainly on the grounds that it assumed that a Second Life player spent their whole life in this virtual world. Admittedly few players would come close but, judging from figures of worldwide energy use, we'd have to conclude that someone playing for just an hour each day would be in the same league as an average inhabitant of Ethiopia or Haiti.

An avatar in Second Life reputedly uses as much energy as a resident of Brazil

However, to emphasise the fact that this is an area in which hard and fast figures are elusive, even this leading authority on the subject admitted he didn't have a current figure for total internet energy use. On data centres, though, he told us that “the latest data showed that about 1.5% of the world's electricity and 2% of US electricity went to power data centres in 2010”.

However, Koomey had no data for end-user devices. “It's not really possible to assign electricity for end-user devices as ‘internet things’”, he told us, “because there's too much ambiguity in tasks.” In other words, it's pretty much impossible to say how much of a PC's energy consumption is due to internet-related tasks, especially because a continuous connection allows our PCs to be exchanging data with the cloud, in the background, without our knowledge.

Yet, even without taking into account end-user devices, that 1.5% figure means the internet uses roughly as much energy as air travel, which has traditionally been a focus of criticism for many environmentalists. What's more, most

In a single hour **1 Airbus** A380 produces  
as much CO<sub>2</sub> as **200m** smartphones

analysts consider that, despite the difficulty in quantifying it, the PCs and smartphones that connect to its periphery are far more polluting than the internet's data centres and communications infrastructure. Even at double the energy use of air travel, there's a lot to be concerned about.

## Greener hardware

Given the huge anticipated growth in internet use, both in the UK and globally, improved energy efficiency is key to its ongoing sustainability. Indeed, the possibility of a bigger and better internet without any increase in energy use is Koomey's hope. "The internet can grow in data flow terms without it using any more electricity," he suggested. "It all depends on the rate of improvement in efficiency. Just because data flows are growing rapidly doesn't mean that electricity use is growing rapidly."

According to Koomey, this is already happening. "Many companies are moving towards renewable energy for powering their IT, and I expect this trend to accelerate in coming years. Moving to areas of clean electricity is one approach, but the better solution is for companies to contract for additional renewable energy, as Google and some other large providers have been doing for years."

As we'll see later, not everyone shares this optimistic view. To get a better feel for how the internet could become leaner and greener, we spoke to Ed King, technical buyer at UK-based Memset, an internet hosting company and the first in this country to be certified as carbon neutral. King purchases both servers and data centre plant and infrastructure with an eye on how efficient everything is.

We started by asking what developments are currently taking place to make servers more efficient. King explained how improvements were being made in several areas, of which the processor, while the most prominent, is just the tip of the iceberg. "We are seeing steady improvements in the energy efficiency of most of the

Data centres consume almost as much of the world's energy as air travel



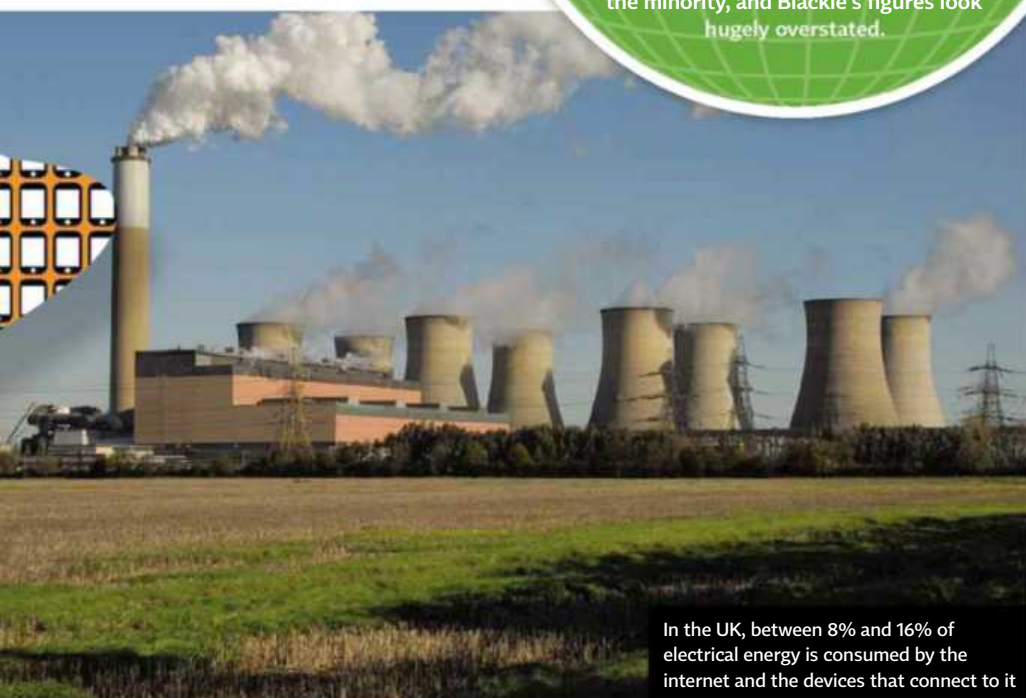
## THE BLACKLE MYTH

Blackle ([www.blackle.com](http://www.blackle.com)) is a Google-powered search engine with a black background instead of the more familiar white. Blackle claims that, so far, it's saved a massive 5,100kWh of electricity. The energy saving is all down to that black background: since it generates less light, it uses less electricity. However, unless you use an old-fashioned CRT monitor, using Blackle will do nothing to save the planet. With most LCD monitors, the backlight is generating light and consuming energy all the time, irrespective of what's on screen. Some monitors and TVs use dimming backlights when dark content is onscreen, but they're still in the minority, and Blackle's figures look hugely overstated.

components that make servers. While the latest generation of Intel's E5 processors draw comparable amounts of power to their predecessors, they manage to fit more cores on to the chip, so you get more computational ability per Watt of electricity."

While memory isn't usually considered power hungry, King explained how improvements here can add up too. "They also use DDR4 RAM, which offers power savings over DDR3. For example, the DIMMs in Memset's new Dell R730s draw 1.2V rather than the 1.35V that the RAM in our older R720s each need. That may not sound like a lot, but when you consider that each server can have up to 24 DIMMs, it can add up to a big saving over a whole data centre."

The move to solid-state disks is also a step in the right direction. "We're seeing a move away from traditional hard drives to SSDs, which, as well as being faster and more reliable, are also more efficient. Eventually, this will lead to significant energy savings," King said. "Finally, modern servers are able to run at warmer temperatures than was previously the case. This means less energy needs to be spent cooling them down. Any servers built in the last five years can tolerate temperatures of up to 40°C, therefore there will be less of a need for compressor-based backup cooling, and with that will come significant cost and energy savings."



In the UK, between 8% and 16% of electrical energy is consumed by the internet and the devices that connect to it

These improvements might be impressive but, in view of the potential for internet growth, what we really wanted to know was how likely it is that improvements in energy efficiency will offset the growth of cloud-based computing. In other words, is there any way we can stay ahead from an environmental viewpoint, or are increased emissions inevitable?

King echoed Koomey's concerns over what we really mean when we talked about internet energy use. "There is a bit of a false dichotomy here, because it's not simply the growth in cloud computing that's using energy, but the growth in all types of computing. I can't see the world's appetite for computing resources being satisfied any time soon, but when done properly, clouds are extremely energy efficient when compared to more traditional methods," he suggested.

As an example, King pointed to the energy saving associated with huge energy-efficient data centres compared to distributed local servers. "There are energy savings to be made when you put a large number of servers in one location rather than having a single rack on premise, because infrastructure can be pooled across multiple users," he explained.

## Cloud efficiency

Given Ed King's assertion that cloud computing can be extremely energy efficient compared to conventional methods, we were keen to investigate this further. Can this apply to ordinary users as well as the corporate users that Memset serves?

Mark Mills is a physicist, tech and energy analyst, co-founder and former CTO of a boutique tech venture fund. He's been following the technologies of computing and communications for decades and has conducted several studies into energy use. We asked him whether

## FAT CLIENTS

Moving our computing into the cloud has many advantages, such as accessing our data from any device we please, and being able to run complex software on underpowered hardware, as the heavy lifting is being done by a server elsewhere and not by our device. This is great if you're using a thin client, such as one of Google's cheap Chromebooks to access its Google Docs office suite. However, if you're still using a big, powerful PC but you've moved your work into the cloud, then you're burning energy at both ends. For most, such behemoths will soon be a thing of the past, but for now many of us are simply burning the computing candle at both ends.



The need for cooling, a power-hungry element of most data centres, is reduced at Memset's facilities

working in the cloud is more or less energy efficient than working purely on a local PC. His response gave us some rather mixed messages.

"A consolidated central system is always a more efficient way to use resources than distributed systems," he asserted, before presenting an apparently contradictory view. "However, that does not mean that the cloud uses less energy than using distributed PCs. The amount of energy used depends on behaviour. All things equal, if there is no behavioural change, then moving an activity into the cloud generally reduces energy consumption. But, as utilisation increases, the energy cost of using the networks rises and can quickly wipe out the energy savings associated with the data centre itself."

To illustrate the point, Mills referred to storing media in the cloud. "Put simplistically, it uses less energy to store pictures and video in the cloud than on your PC but it takes more energy overall if you start accessing the files more frequently." Interestingly, it really doesn't take a lot of accesses before the cloud starts to use more energy than

In Pisa, Italy, embedded sensors, local transmitters, a smartphone app and smart signs all work to help motorists find elusive parking spaces, which cuts down on CO<sub>2</sub> emissions and pollution in the city centre





local storage. According to Mills' 2013 report *The Cloud Begins with Coal*, the breakpoint is just 10 downloads per hour of 1MB photos.

It's hard to estimate just how many photos are being viewed online, but in 2011 Facebook alone was getting 250m photos uploaded every day. And it's not just traditional holiday snaps; every image you see online, be it a picture on a news site, a product image on Amazon or a cute cat your friend shared on Facebook, is being served

from a data centre somewhere. It's mind-boggling when you think about all those images being served to us all every day, largely without flaw. The benefits may be arguable, but the logistics are impressive.

So while migrating to the cloud is power efficient, increased use could counteract that. Mills isn't especially optimistic about which would win out. "Of course, the cloud, and local devices, will continuously become more energy efficient. This has been the nature of all computing

## Greener cars

We've established how cars can achieve improvements in efficiency by becoming part of a connected world (see page 106), communicating with transport infrastructure such as traffic lights. Cars are also becoming greener in themselves but, contrary to popular belief, this is more to do with computer intelligence than any move from petrol to electric propulsion per se.

The naive view, of course, is that electric cars are better for the environment than gas guzzlers because electric motors don't generate carbon dioxide. While this is true, it's ignoring the fact that electricity doesn't grow on trees and generating it could well result in the production of greenhouse gases.

The same applies to hydrogen-powered cars, since hydrogen doesn't occur naturally. Manufacturing hydrogen requires energy, and this too results in the release of carbon dioxide, unless you happen to live in a country with abundant hydro, geothermal or nuclear power generation.

Since pretty much all ways of propelling a car are potentially polluting in some respect, the greenest vehicles must surely be those that employ the most efficient technology. Petrol engines are, at the most, 40% efficient (in terms of energy going in and energy produced in terms of power). Electric motors have an efficiency of up to 90%, but when we factor in all the other aspects, most notably the efficiency of electricity generation, this can vary immensely depending on how the power was created in the first place.

Where the electric motor wins hands down, though, is in how it can manage that power in typical driving conditions. While some petrol-driven cars now stop their engine when idle, this is far more efficient with an electric motor and, most importantly, instead of



Electric car manufacturer Tesla has made huge advances in bringing over-the-air software updates to its customers

throwing away energy as heat when braking, electric cars can employ regenerative braking, in which the energy created is used to charge the battery.

All this can be done with just on-board intelligence but, just as today's PCs are heavily dependent on the internet, increasingly a car's internal workings rely on connectivity for improved efficiency. Included here are automatic over-the-air firmware updates, just like those to your mobile phone, in order to tweak performance after the car has been launched. Transmission of data back to the manufacturer also allows it to schedule maintenance more accurately. Since an up-to-date and well-maintained car is an efficient one, the environmental benefits aren't hard to appreciate.

and communications for decades. As efficiency rises, the effect has been to increase total data use and traffic, and those increases have always resulted in a net increase in total energy use associated with data. So energy-use-per-bit drops, but total bit use increases far faster, so energy use goes up. This has been the trend for decades. There is no evidence that this will stop."

## Hidden benefits

Although opinions differ on whether moving to the cloud will reduce or increase the total energy used by computers, the internet clearly offers environmental benefits in other areas. What's more, some of these applications are not at all obvious beneficiaries of cloud computing.

Road transport is responsible for 12% of the world's greenhouse gas emissions, so any improvements here would be particularly welcome, and the internet could play a major role here. A project in the Italian city of Pisa has already reaped benefits and hints at the advantages that an internet connection can bring to road travel. Many of us already benefit from being able to get from A to B without getting lost or hitting congestion, thanks to satellite navigation devices with access to real-time traffic information, but for drivers in Pisa, technology can also guide them to the closest free parking space. Given that motorists driving round and round the city streets looking for a free

Researchers at Newcastle University aim to reduce emissions by eliminating stop-start driving at traffic lights



## THE NEW PC PARADOX

You might like the idea of trading in your dinosaur of a PC for a new model, but if you think you'll be playing a part in slowing climate change, think again. End-user devices account for a significant proportion of internet energy use and, if your old PC is more than a year or two old, the chances are that its replacement will have far better green credentials.

However, the fact is that the energy used to manufacture a PC is far greater than the amount of energy it will ever consume throughout its entire life. From a purely environmental viewpoint, therefore, you'd be better off holding on to your ageing PC for a bit longer.

exchange between cars and traffic lights. Initial trials have involved fitting equipment to Newcastle Hospitals NHS Trust's passenger transport vehicles. By giving priority to these vehicles, patients can be transported more quickly, more comfortably and more economically by reducing stopping and starting. If rolled out to more vehicles the system might advise a driver, for example, that if they travel at 24 miles per hour they will hit the next four sets of traffic lights on green. Since stopping at lights wastes energy, such a move could reduce pollution in city centres and, at the same time, reduce global emissions. In more congested areas or at particularly busy times of the day, vehicles on key roads might be given priority in order to keep the traffic flowing, again with environmental benefits.

## Turn IT off...

Environmentalists and technologists will continue to differ on whether the greenhouse gases produced as a result of the world's love of technology is worth the benefits provided. However, much of the environmental impact of computing provides no benefit at all, as so many devices are left on constantly, even when unused. According to statistics, 50% of PCs in the USA are never switched off, accounting for a huge and unnecessary power drain on the grid.

There is some good news, though. Years ago, a processor used as much energy while it was idle as it did when it was hard at work. With today's emphasis on energy efficiency, processors can be put to sleep when they're not at work, and components such as hard disks don't have to work as hard in an idle PC either. Estimates suggest that 73TWh (73 billion kilowatt hours) of energy is wasted in this way each year, an amount that will result in the production of 30 million tonnes of carbon dioxide. The same amount of energy would heat over four million homes.

Much of this waste can be reduced by using the energy-saving options that are provided in Windows, but the obvious answer is



just to turn your PC off (or put into a very low-power hibernate state) when you're not using it. For many years, it was argued that turning a computer off each day would cause it to wear out more quickly, but that notion has now been discredited. What's more, as well as doing your bit to save the planet, you would also reduce your electricity bill.

## ARMED FOR CHANGE

ARM's processor cores are generally associated with mobile phones, but its 64-bit offerings have a lot more potential than this might suggest. Indeed, several companies now offer server products based on ARM technology and claim high levels of energy efficiency. Given ARM's heritage, and the fact that energy isn't too plentiful in handheld battery-powered smartphones, low power consumption has been a hallmark of the company's processor cores. It's interesting to note, therefore, that this efficiency is now proving its worth in the very data centres on which these mobile devices rely.

HP now offers ARM-based processors in its energy-efficient server products

### Mail model

In 2014, the Royal Mail delivered 37% fewer letters than its 2005 peak of 68 million per day, and the figure continues to fall at more than 6% per year. This decline is largely thanks to internet technologies such as email, messaging services and social media.

It's hard to find figures for the environmental impact of a letter, but delivery in the US was once calculated to produce 25g of carbon dioxide per letter, with production of the letter itself roughly double that. Recent research estimates that a read email creates 4g of CO<sub>2</sub>, which is around a tenth of a delivered letter (read or unread).

However, for every read email there are numerous unwanted spam messages. Thankfully, spam has a much smaller carbon footprint, estimated at a tenth of a read email, as most are never opened or displayed onscreen. As usual with these discussions, though, the sheer volume of spam offsets that saving somewhat, with security company McAfee estimating that 78% of emails are spam, around 62 trillion messages, producing 20m tons of CO<sub>2</sub> every year.

When it comes to the email we actually want, it's worth noting that we send many more emails every day than we ever sent letters or internal memos. The benefits are huge for businesses, of course, and surely no one wants to go back to waiting days for an important letter to turn up in the post.

### A greener future?

While it seems that few people have accurate facts and figures at their fingertips, there are two things we can be sure of: the internet uses a lot of energy, and its use is going to grow. This is the bad news from an environmental viewpoint. The good news is that improvements in the efficiency of servers will go some way to offsetting the impact of this growth,

although it seems likely that increased use will more than cancel out this benefit.

Will the internet reduce energy consumption elsewhere and, in so doing, pay for itself environmentally? That's the \$64,000 question and, while answers aren't forthcoming, it does look likely that the internet will be an essential part of many modern technologies that are improving efficiency across the globe. In short, it might prove to be part of the solution rather than the problem.

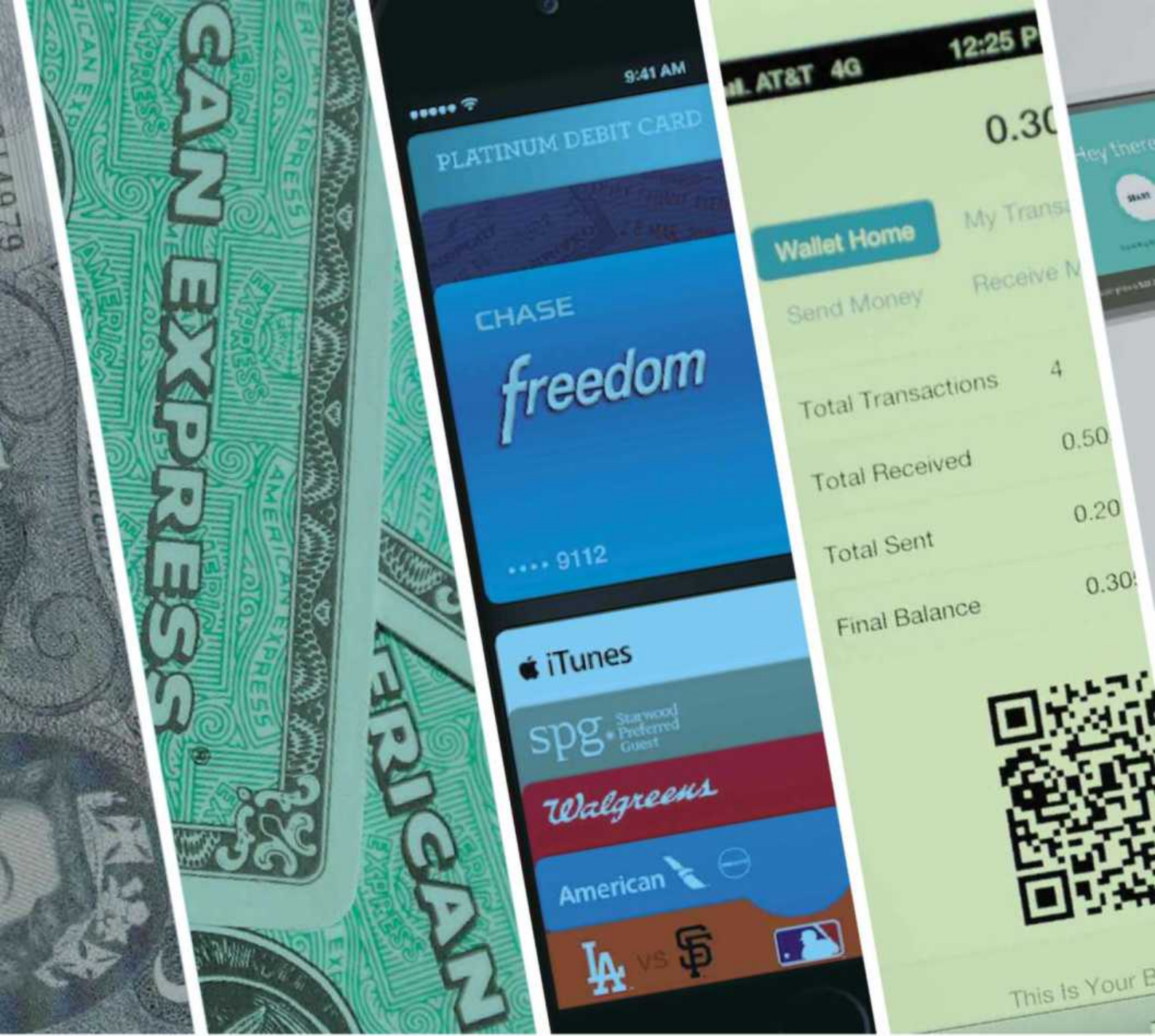
If that doesn't happen, we could console ourselves with the knowledge that the internet has made life easier and more enjoyable for billions of people, but we'll leave you to decide whether the price is one that's worth paying. ☐



Emails generate a lot less carbon dioxide than traditional mail



# Monetary *Evolution*



## The cash in your pocket may not be there much longer. *Simon Handby* looks at how technology is changing our currency

**M**oney might not buy happiness, but for millennia it's oiled cogs, greased palms and essentially made the world go around – at least, until now. With the arrival of Bitcoin, Apple Pay and other disruptive technologies, many of our financial mechanisms suddenly look outdated and unwieldy. The way we make and receive payments is changing rapidly, and with it our notion of money and the importance of currency could also be about to shift. Here we look at the future of money, and ask if the pound in your pocket is about to get cashed up.



Something funny is happening to cash. You've probably got notes in your wallet and some coins in the car – maybe you've even got emergency funds stuffed under the mattress – but the chances are that you're using it less often, and for things of less value. According to the British Retail Consortium (BRC), the proportion of retail transactions settled in cash fell by more than 5% in the five years to 2014. At the same time, the average value of those transactions fell much faster, by more than 33%.

Conversely, the Bank of England, responsible for issuing paper money and ensuring the stability of the pound, says the demand for bank notes is increasing rapidly, outpacing the growth in GDP since about 1990. In its third-quarter bulletin this year, the Bank noted that only about a quarter of cash is actually being used for transactions; the rest is being exported, hoarded, or used to support the shadow economy. So what exactly is cash, and if it's a boon to drug dealers, tax-evaders and organised criminals, can't technology replace it with something better?

### The penny drops

It may be stating the obvious, but money's been around for a long time. From at least as far back as 9,000BC, items with a high value, such as grain or cattle, were being used as an intermediary in transactions. Essentially a more sophisticated form of barter, this 'commodity money' relied on the high value of the items acting as the intermediary,

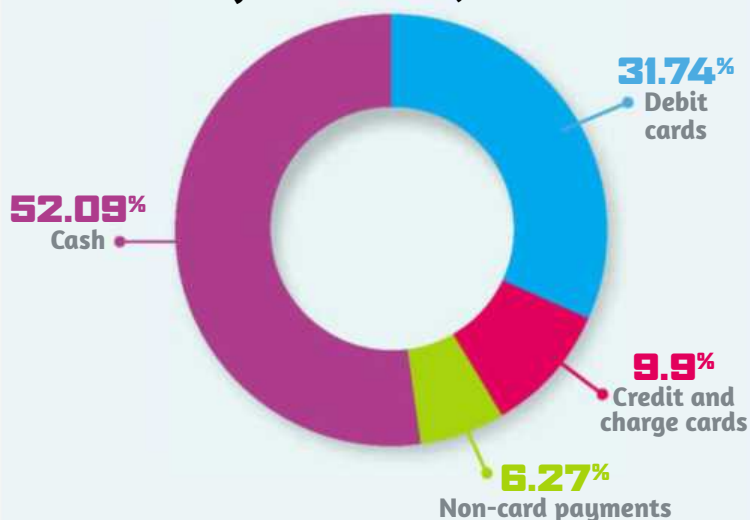
**Cash makes up just 3% of the broad money supply; the remaining 97% is stored electronically**

but by the ninth century AD, the receipts issued for deposits received by merchants had themselves started to be accepted in trade. While the receipt itself had no value, what it represented did.

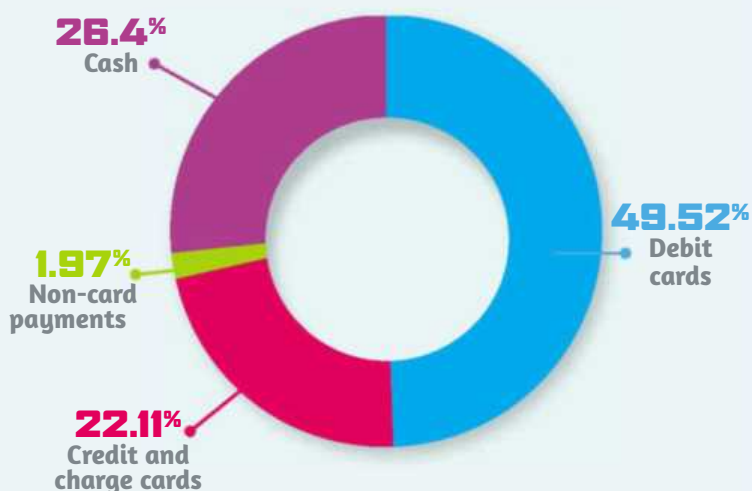
It's from these beginnings that money evolved as a medium of exchange, but while cash is the convenient token we use to represent that money, in developed nations it's by no means the bulk of the money that exists. In the UK, cash makes up just 3% of the broad money supply; the remaining 97% is stored electronically, within the financial system (see 'Who's making all the money?', page 112).

Clearly, the importance of cash has been diminished by technologies that represent money in this way, but it still plays some important roles. Cash is vital to those with a poor credit history, who may find themselves locked out of

### Percentage of turnover by number of transactions, 2014



### Percentage of turnover by value of transactions 2010-2014



↓ The earliest examples of this Greek drachma date from 700BC



bank accounts and other financial products. It's often the easiest way to settle a small debt, while its importance to trade shouldn't be underestimated: the BRC says it still accounts for 52% of all retail transactions. Of the remaining 48%, the vast majority are settled by payment cards.

### On the cards

Cards such as Visa, MasterCard and American Express came about in the US in the mid-20th century, emerging as products that saved the customer having to open and manage credit accounts at multiple stores. While charge cards like Diners Club already existed, Bank of America's BankAmericard – launched in 1958 – was the first successful all-purpose credit card. After a rocky start, it became an overwhelming success, rebranding in 1976 to Visa.

While we talk of Visa cards and MasterCards, the two are essentially branding for the back channels through which the merchant and customer's banks talk to each other. The cards themselves are issued by the customer's bank, which decides the bulk of their terms, the credit limit and credit interest that are applied. To provide an almost instant authorisation, the system relies on quick

**“What an idiotic system: if I pay someone, I tell them everything they need to spend my money”**

communication between five parties: the cardholder, the retailer, that retailer's card services partner or 'acquirer', the card scheme, and lastly the cardholder's bank.

In a typical UK transaction, the cardholder inserts their card into the retailer's chip and PIN reader and provides their PIN, after which the transaction data is collected by the acquirer and presented to the relevant card scheme for authorisation. The Visa or MasterCard network routes the transaction to the cardholder's bank, which approves or denies it depending on the customer's bank balance or credit status. Its response then moves back down the chain to the merchant.

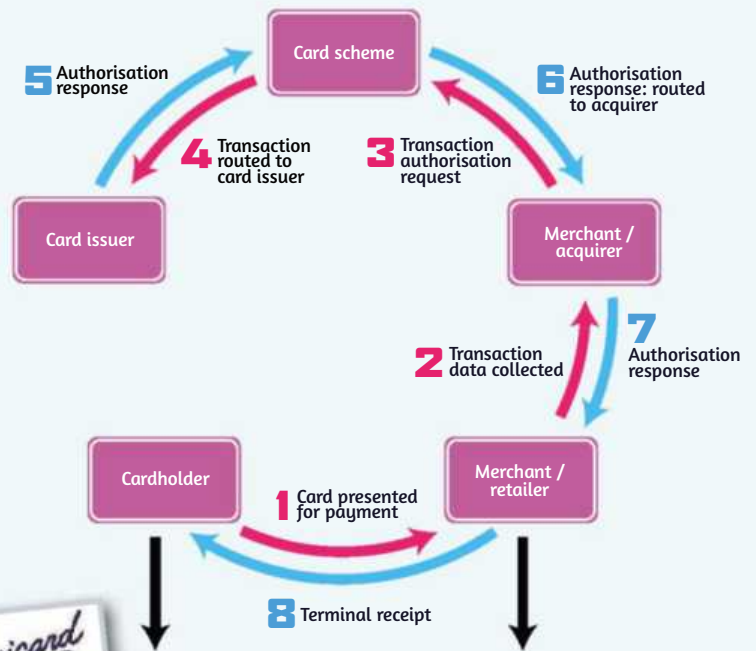
It's a well-established, quick and reliable system, but it's not perfect. As Stanford Business School economist Susan Athey explained to *Forbes* magazine: "When you pay for something with a credit card, you're giving someone all the information they need to buy something online. What an idiotic way to architect a system: that if I pay someone, I tell them everything they need to spend my money."

### Money on the move

The three major new mobile phone payments systems – Apple Pay, Android Pay and Samsung Pay – all work with the existing card infrastructure. In all three, you set the phone up to make payments by adding details of an existing debit or credit card, after which you can present the phone at the till, rather than using the card itself. However, they also use 'tokenisation' for additional security – a process where something sensitive (your card number) is replaced by something non-sensitive, such as a code made up of random numbers.

In this case the merchant and card issuer trade a unique number that represents your card details, together with a one-time cryptogram generated with a key stored on the phone. In theory, this prevents the scenario outlined by Athey: even a dodgy merchant can't intercept and re-use your card, as the details they receive are only applicable for that one-off transaction and so can't be used to buy further items elsewhere.

### How card payment schemes work



↑ Card schemes such as Visa or MasterCard are essentially rapid back-ends for electronic funds transfers



We doubt that BankAmericard would have got very far without its name change

Android Pay – coming soon to an expensive greengrocer near you

One area where the three services differ from each other, aside from the fact that Apple Pay is the only one to have launched in the UK yet (see issue 332), is in how they talk to existing point of sale (PoS) technology. All three use near-field communications (NFC), and thus can be used with Contactless terminals, but Samsung Pay can also use Samsung's proprietary magnetic secure transmission (MTS) technology, which mimics the action of swiping a card's magnetic strip through a reader. It's this that forms the basis for Samsung's claim to have the most widely accepted system, although reports suggest that MTS is particularly sensitive to the correct positioning of the phone.

According to the BRC, 42% of all the UK's manned PoS terminals are now Contactless. It's worth noting that Contactless itself is a brand and a standard, run by the UK Cards Association, a trade body that represents the card issuers and acquirers in the UK. Contactless payments jumped from just 2.6% in July 2014 to 8% in July 2015, with even stronger growth predicted for next year.

### Net value

The rise of internet shopping has meant that, for many consumers, much of their card spending now takes place on the web rather than in shops. According to card-processing firm Payvision, the UK settles 35% of online transactions by debit card and a further 40% by credit card. You can't just swipe a card in a website, though, and as the plethora of data leaks from high-profile websites shows, you can't necessarily trust them to store your financial details. This has helped drive the uptake of alternative payments services such as PayPal, which accounts for most of the remaining transactions, some 21% of UK online spending.

When you click the 'Check out with PayPal' button on a website and you don't have a PayPal account, you can use the service to make a typical card payment by providing card details as you would on any other site. However, account holders can log in and pay either via cards they



# Who's making all the money?

It's essential that the supply of money can grow in order to permit an expanding economy, but you may be surprised where most money comes from. In England and Wales, cash is produced by the Bank of England and the Royal Mint, but the bulk of new money is created by private banks when they make loans such as mortgages. As the principle (the initial loan sum) is paid off, the money is effectively removed from the economy again.

Under this system, the creation of money is inexorably linked to the creation of debt, and thus the economy can expand only while indebtedness continues to increase. However, as Ben Dyson, head of research at Positive Money, explains, it's not a system we've actively chosen. "It's something that's evolved almost by accident, and it's not necessarily something that you would design if you wanted a stable economy."

Dyson says that the current system is analogous to that in the early 19th century,

It's not the Bank of England that creates most of the money in the UK economy

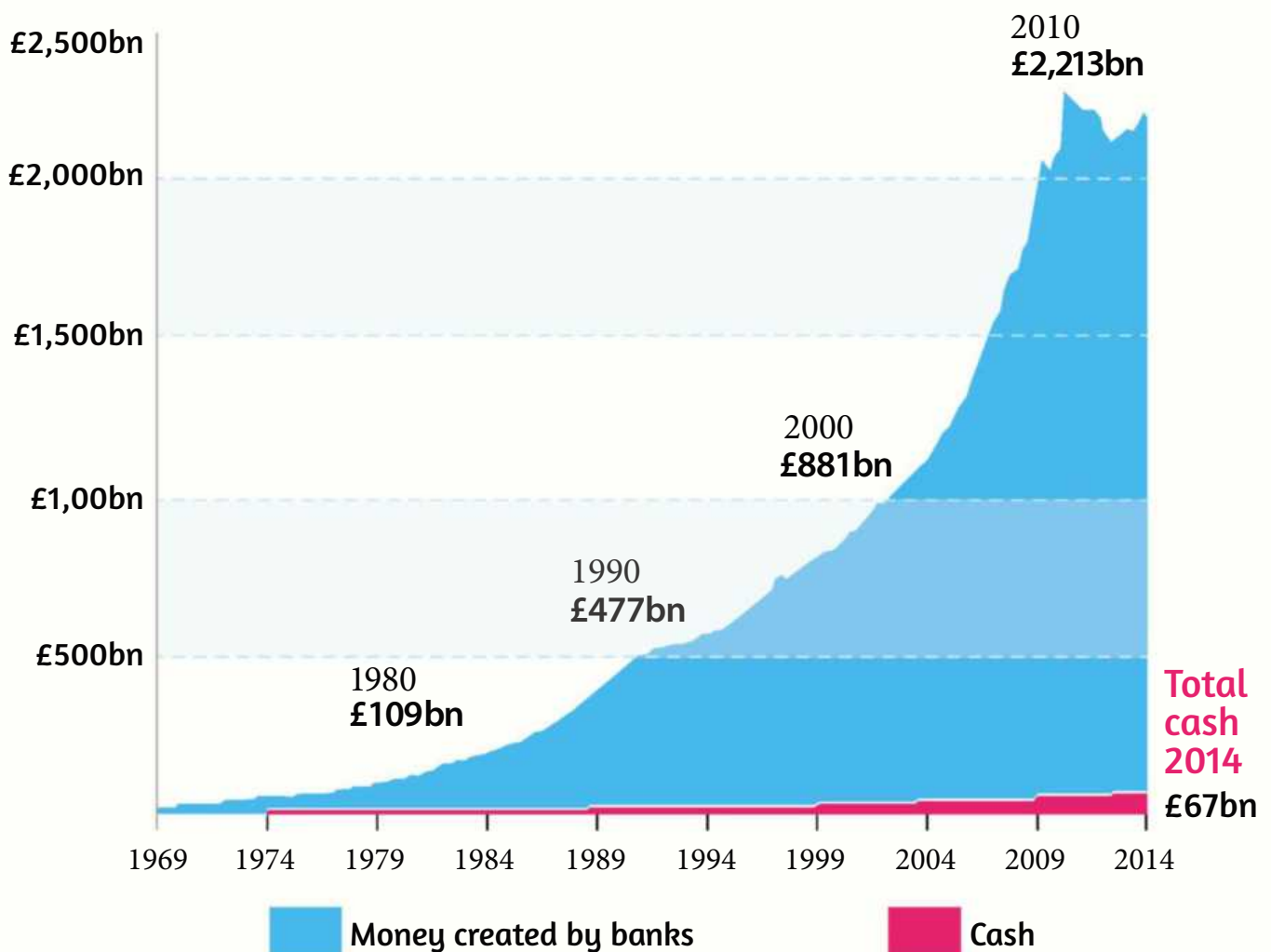


when private banks could still issue their own paper cash – essentially IOUs for deposits – but there was little to stop banks issuing more cash than they could honour.

Positive Money campaigns for a fundamental change in the system, where a committee within the Bank of England would decide at what rate money should be created, with money used to stimulate the economy, possibly through funding tax reductions or large-scale public projects, rather than the financial sector.

Referring to the Bank Charter Act of 1844, Dyson points out that the UK has already passed legislation to stop private banks creating money, but that this law didn't anticipate the electronically stored money at the core of the modern financial system. Consequently it hasn't restricted the supply, and "the fact that the power to create money has been gradually shifting to the banks hasn't really been flagged up".

## Licence to print money: how supply has increased







Credit unions can help provide financial services to those who otherwise wouldn't have access, breaking the dependency on cash

have stored in their PayPal wallet, by a linked bank account, or by using their 'PayPal balance' (you can charge this manually, or it appears from refunds or from selling; see below). For card transactions, PayPal works with acquirers in the established card transaction scheme, while for balance payments the money is simply transferred to the merchant's PayPal account. The company makes money by charging merchants a transaction fee, but it also benefits from holding its customers' PayPal balances.

### App you up

Services such as PayPal save consumers the headache of repeatedly providing card details, but they also reduce overheads and commitments for a seller: anyone can open a PayPal account and receive payments, either as a merchant, or informally from other users. Such services don't just make it easier to take electronic payments online: PayPal now sells a small, cheap, card reader designed to work in tandem with PayPal on a mobile device, while in the US, rival Square offers the Square Register, a smartphone-based digital PoS system with free basic hardware that costs the retailer 2.75% of each transaction.

For consumers, and certainly for the future of cash, one of the biggest changes offered by mobile phones is the ability to quickly settle a small debt without messing about with bank details. Peer-to-peer (P2P) payment apps such as Pingit or Venmo make it as easy to split bills or cab fares as

digging a £10 note out of your wallet, whereas for larger debts they're much handier than a bank transfer.

For digital money expert Dave Birch, it's this ability to receive payments through our phones that will, ultimately, spell the end of cash. "What's happened is the mobile phone has become a way of taking payments," he says. "That's the revolution... that's what displaces money."

Speaking at the 2013 Meaning conference in Brighton, Birch went on to explain: "I could use cards everywhere, though only in shops, so I still needed to use money because I might need to pay you. But when you can take cards, my phone can just pay your phone. And since my phone can now pay your phone, we don't even need to mess about with the cards any more – it's just my phone paying your phone."

Considering the potential impact of a mobile phone that can both make and accept payments, it's perhaps a surprise that Apple Pay, Android Pay and Samsung Pay haven't supported P2P from launch. However, potential headlines linking the services to illegal activities may have something to do with that. Still, there are strong rumours that Apple plans to introduce it, and it seems likely to make its way into rival services before long.

### Access: a flexible friend

Dave Birch isn't alone in prophesying the end of cash, with many others believing that a digital equivalent will displace it. The Bank of England's chief economist, Andy Haldane, recently suggested the enforced end of cash in favour of a digital wallet, but clearly – given the stubborn popularity of notes and coins – it's not going to happen overnight. While it may be desirable to prevent criminals using cash, there needs to be a suitable alternative for poorer members of society who, denied access to formal financial services, may currently be locked into the cash economy.

## Blockchain reaction: how Bitcoin works

The key to digital currencies such as Bitcoin is the shared ledger: basically a big spreadsheet, available to everyone, which keeps track of who owns what. The ledger – known as the blockchain – is continually updated by participating computers that work to verify transactions through a process called mining. Roughly every 10 minutes a new block of transaction history is validated and appended to the ledger. With no central authority maintaining the system, it's imperative that it can't be fraudulently manipulated, so each new block is a cryptographic hash of the previous one, creating a secure 'chain' of blocks. Trying to falsify an earlier transaction, and hence block, is effectively impossible, as you'd also need to falsify the subsequent blocks and have them accepted by the system's nodes.

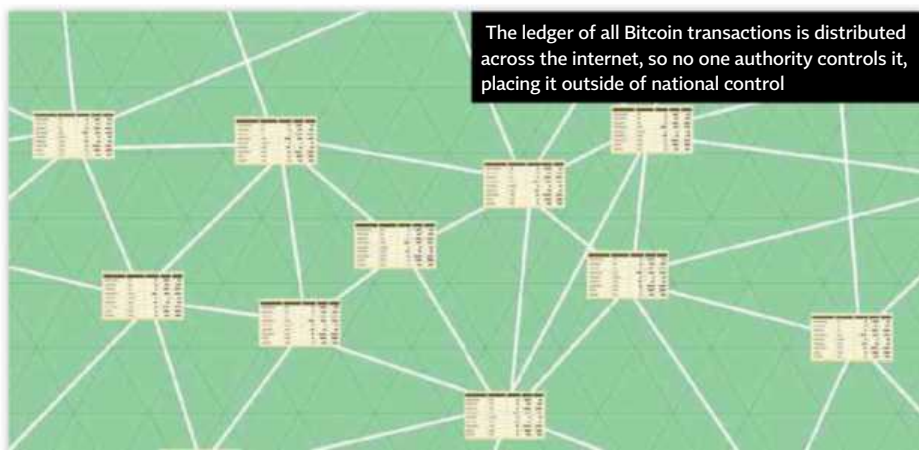
Among the blockchain's advantages are that the currency and its storage and payments systems are intrinsically linked: once you have a Bitcoin wallet, for example, you have everything you need both to hold Bitcoin and use it in transactions. This has the potential to obviate not only systems such as Visa, CHAPS or Faster Payments, but even bank accounts – potentially a great

benefit to the economically marginalised, or those in countries with unstable or undeveloped financial systems.

Bitcoin is a pioneering crypto-currency undergoing rapid growth, however, and as such it faces issues such as the current debate about how it should scale. In essence, the Bitcoin community is split between those who believe the maximum block size must soon increase from one to eight megabytes, and those proposing alternative solutions. The former have created an alternative mining client and proposed a fork in the currency, to be called Bitcoin XT. If, by January 2016, more than 75% of miners have switched to the new client, the Bitcoin

blockchain will fork into Bitcoin XT, and take the majority of miners with it.

In Bitcoin's decentralised system, transactions remain free because miners are rewarded with Bitcoins for each block they verify, but the difficulty of doing so scales up with popularity of the system. The days are long gone where casual miners could earn significant profits, and as Ben Dyson points out, once large-scale mining operations are unprofitable, the currency is unlikely to remain free to use: "When the rate of mining new Bitcoins declines effectively towards zero, the transaction fees have to go up and up to make it worthwhile for miners to continue to run the infrastructure."



The ledger of all Bitcoin transactions is distributed across the internet, so no one authority controls it, placing it outside of national control

One way to remove people's dependence on cash may be through increased competition and openness in the financial services market. At present, according to Positive Money's Ben Dyson, the inter-bank payments systems such as BACS and Faster Payments are "a bit like a cartel" under the control of big banks, where the regulatory burden makes it extremely hard for new entrants to take part. Dyson told us that Positive Money had submitted proposals to the new Payments Systems Regulator and to the Competition and Markets Authority that would make it easier for small companies to offer alternative financial services. Offering the example of a technology startup launching a simple, smartphone-based bank account, Dyson says that simplified regulation would allow new entrants the access to the inter-bank payment systems they'd need in order to compete.

Dave Birch told us that there's a recognition among the banks he talks to that the mobile phone can help open up the market to the wider population, without everyone necessarily needing a bank account. He cites the example of a successful trial with the South Yorkshire Credit Union, in which members were given a pre-paid charge card. "Pre-paid cards when they were tried before were a bit of a pain, because you have to go to [a cashpoint] to find out how much money you've got," he explained. "Pre-paid cards combined with an app is a bit of a revolution."

### Currency affairs

In a bright future where the disadvantaged are liberated from the cash economy, and everyone can make instant mobile payments, things might look very different. As Dave Birch puts it: "When all the cash goes away, and all the point-of-sale terminals go away and everybody's just using their mobile phone, it means the kind of money that you use is just another menu on your mobile phone. I don't care whether [the people I'm paying want] euros or yen or dollars: that's the kind of boring detail that my phone can sort out with [theirs]."

What this means, according to Birch, is that we would no longer be bound to using national currencies such as the pound, even leaving us free to start our own. This has, arguably, already been tried in towns including Totnes in Devon and Lewes, East Sussex, where many businesses



The Lewes pound originated as a way to encourage demand for local goods and services in the East Sussex town

accept either the Totnes or Lewes pound. The Bank of England considers these and other such local currencies to be voucher schemes, however. Although they're legal, the Bank is quick to point out that they don't offer consumers the same level of protection as the pound, and that it's illegal for anyone to actually print bank notes.

For an example of the penalties that might be applied, we can look to the US and the Liberty Dollar, a private currency produced for about 10 years starting in 1998. For a time the US government seemed ambivalent, apparently trying to decide whether the currency was in competition with the dollar or not. By 2006 the Justice Department had apparently determined that using Liberty Dollars as circulating money was a crime. In 2007 the Liberty Dollar offices were raided by the FBI and the precious metals on which it was secured were seized. In 2009 charges were brought against the currency's founder, Bernard von NotHaus, who in 2011 was convicted of "making, possessing and selling his own coins". His appeal failed, and in December 2014 von NotHaus was sentenced to six months' house arrest, with a further three years' probation.

Such an outcome might sound ominous in the context of digital currencies, but when it comes to Bitcoin, at least, western governments appear united in accepting it as a legal and valid alternative. In a future with national currencies potentially diminished by mobile technology, and

## Taking notes: cash in the UK

Since its inception in 1694, the Bank of England has been responsible for issuing banknotes, although only in 1844 did it gain its monopoly over note issue in England and Wales. The process might not be funded as you'd expect: while each note costs the bank a few pence to print, the Bank sells them at face value, generating a profit. After deducting costs – including those of buying back end-of-life notes at face value – the remaining revenue goes to the government and is known as 'seigniorage'. Far from costing money, the issuing of bank notes generates revenue for the Treasury.

Current notes are printed on durable cotton fibre paper, with multiple security features designed to prevent counterfeiting. Lower-value notes have a lifespan of only months; until 1990 old notes were used to fuel the Bank's heating, but these days they're destroyed and composted instead. Talking of excess, by 2010 UK bank notes had become so contaminated with cocaine that the Forensic Science Service stopped even testing for it in criminal cases.

In the second half of 2016, the Bank will introduce a more durable £5 note printed on polymer, while a new £10 note will follow a year later. The Bank says that the new, 15% smaller notes will be cleaner, more secure, and will last two-and-a-half times longer, after which they can be burned for energy or recycled into other plastic products.

Within two years, new £5 and £10 notes will be printed on polymer rather than paper



trade and culture increasingly globalised by the internet, might a new global, digital money emerge?

For the savvy internet user, Bitcoin certainly offers lots of advantages. Users have no need for a bank account, and currently pay no transaction fees; a boon particularly in the US, where bank transfers generally aren't free as they are in the UK. It's certainly not without problems, though, from the current divide over block size to a wildly unpredictable exchange rate with other currencies. But if it's doubtful whether the world is ready for an all-conquering cryptocurrency, there is a growing mainstream interest in their underlying technology (see 'Blockchain reaction', page 113).

In February 2015, the Bank of England's One Bank project invited research on how a Bitcoin-style distributed ledger might be used by a central bank to issue a digital currency, and the impact this might have. In a September 2015 speech to the Portadown Chamber of Commerce, Andy Haldane said that such technology solved the problem of "how to establish trust – the essence of money – in a distributed network". However, not everyone would welcome one of the potential applications Haldane sees for a digital currency: the ability for the state to then levy a negative interest rate on cash to encourage spending.

The Bank of England isn't the only institution attracted by Bitcoin's technology. In September 2015, financial technology firm R3 announced that it had signed up nine private banks – including Barclays and the Royal Bank of Scotland – to a project looking at how blockchains could be applied to the global financial system.

**Transaction stations**

Money itself might not be changing any time soon, but technology is bringing increasingly rapid changes to the mechanisms that underpin it. Before too long, banks, individuals and institutions may transact directly through distributed ledgers rather than today's mechanisms. In the longer term, an improved and universally accepted digital currency might still emerge, with the potential to displace national currencies altogether.

**For the savvy internet user, Bitcoin offers lots of advantages**

What seems more immediate, however, is the demise of cash. While it remains stubbornly popular despite steady inroads from debit cards, wider acceptance of both cards and Contactless payments will erode people's dependence on physical money. At the same time, more and more smartphone users with more sophisticated apps at their disposal are likely to find themselves using cash, and even the existing card payments infrastructure, less and less.

Dave Birch helped set out how shopping might change in the near future: "If I'm in Tesco my Tesco app will pop up on my phone because of Bluetooth beacons or whatever. The little scanner thing will light up, I take the scanner and go round scanning things, chucking them into my cart.

"And at the end I put the scanner back, and the app pops up on my phone and says 'that's £27.50'. I put my thumbprint on it and off I go. I won't go to a point-of-sale terminal at all." Having done that, the app can then charge your default payment option automatically, be that a card through Apple Pay, talking to your bank app, your Bitcoin wallet, or possibly the UK's own crypto-currency. Whichever you choose, it's a very different way to pay. ☑

**The growth of payment cards**

Since 2011 debit and credit card spending has risen sharply. The success of chip and PIN in protecting consumers, retailers and banks – at least compared to the old sign-on-the-line 'security' system – has seen card use boom in the past few years, as more and more of us use them for small everyday purchases. This trend should continue, with Contactless payments more than tripling in the last year alone. This added convenience will be a further blow to cash.

**Total value of debit and credit card sales**



**Total number of debit and credit card purchases**



**Percentage of Contactless payments**



# ***SUPERCARGE*** **YOUR INTERNET**

A poor internet connection can be caused by slow or dodgy DNS. We show you how to check and change your server

If your internet connection is playing up at home, the natural thinking is that the fault is either with your broadband, your router or the Wi-Fi connection at home (or a combination of the three). In reality, a lot of faults are caused by the Domain Name System (DNS). This is a crucial part of how the internet works and, when it goes wrong, it can cause massive problems, even though the internet connection itself is working properly.

## **What does DNS do?**

Before we get into how you fix the problem, it's important to understand what DNS does and how it works. The best way to understand it is to think of the internet as two layers: on top are the human readable addresses that you use in a web browser, such as [www.expertreviews.co.uk](http://www.expertreviews.co.uk); underneath are the machine-readable IP addresses. Every computer on the internet has its own unique IP

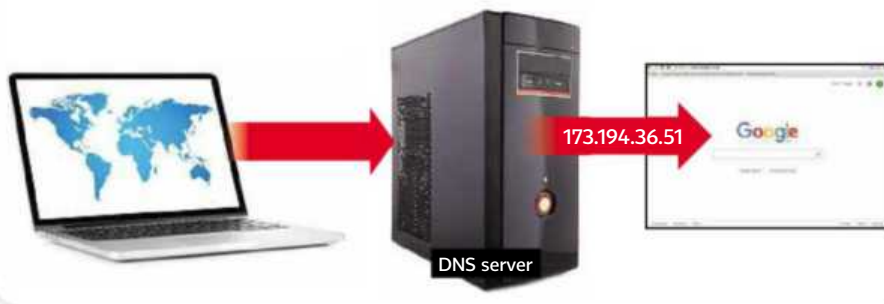
address, which is written as four numbers separated by full stops, such as 172.238.118.72, which can be thought of as its postal address.

DNS servers are charged with the job of converting the human addresses we use into the IP addresses that your computer uses. So, when you go to your browser and type in a web address ([www.expertreviews.co.uk](http://www.expertreviews.co.uk), for example), your computer connects to its DNS server (usually provided by your ISP) and looks up the site's IP address (54.247.85.215 in this case). Using this information your browser can then connect directly to the server.

Now, if your DNS server has issues or goes down, your browser will be stuck waiting for the IP address to be returned. The problems get worse as a website will generally require your browser to make multiple DNS lookups, such as for each picture, advert and other onscreen elements. In this case, a slow DNS server can make a website load slowly or even make it fail to load certain elements.

## How DNS works

A DNS server changes a web address that you understand into an IP address that your computer understands



### How can I improve DNS speeds?

Your router will be configured to automatically use the DNS servers as provided by your ISP. These typically aren't the best and can be slow or suffer from regular outages. The answer is to use a different third-party DNS server instead. There are plenty of these available (more on this later), most of which are more reliable than your ISP's own servers.

You can also get a range of different services by changing DNS servers. For example, web filtering of adult sites is a popular service, which can help protect your children when they're online. If anyone tries to access an adult site, the DNS server returns the IP address of a page that contains a block message, preventing access to the inappropriate site. Other DNS providers filter

out websites that are known to be malicious or to be full of malware.

The clever thing about all these systems is that they're device-agnostic, so they'll stop a phone from accessing a site as easily as a PC, all without using any software. We'll take you through the options over the page.

### How do I change DNS address?

There are two main methods for changing DNS server. The best way is to alter your router's settings, so that it dishes out the new DNS server addresses to any device that connects to your network. This is not an option on all routers, so you may have to change settings on a device-by-device basis.

Our guide on how to change DNS server settings on the following page will help. This guide specifically talks about how to change to Google's DNS servers in order to work around BT DNS problems, but you can use the instructions, only switching the Google server addresses for your DNS server of choice.

# Best DNS servers



Google has been providing DNS servers for a few years, and its servers are among the best available. As one of the biggest internet companies, Google's DNS servers are hugely reliable and quick to respond, and it has servers around the world. Its servers do not have any blocking or filtering built-in (the company has said it would only block something under exceptional circumstances), so it's a great choice if you only want a faster version of the system you're currently using.

#### Google DNS server addresses:

8.8.8.8	8.8.4.4
---------	---------



OpenDNS ([www.opendns.com/home-internet-security](http://www.opendns.com/home-internet-security)) is a big name in DNS, with the company also providing filtering against malware and, primarily, adult sites. This is a great choice if you've got children and want to control what they're looking at. If you just want to filter adult sites without taking any control, then you can use the free OpenDNS Family Shield DNS servers (see below).

The next step is to use OpenDNS Home. The basic version is free to use, but if you also create an account, you can choose the level of protection you want to apply and the types of sites you want to filter.

Finally, the top option (\$20, around £13, per year) lets you add optional whitelist sites (those you don't want to block) and gives you more reporting and stats.

#### OpenDNS Family Shield server addresses:

208.67.222.123	208.67.220.123
----------------	----------------

#### OpenDNS Home server addresses:

208.67.222.222	208.67.220.220
----------------	----------------



Norton ConnectSafe (<https://dns.norton.com>) is a service provided for free by the makers of the popular internet security suite. It has three levels of filtering built in, which you choose by using the applicable DNS server addresses (see below). Policy A just filters malware, phishing and scam sites; Policy B filters everything that A does, plus pornographic sites; Policy C filters the same as A and B, plus sites that contain mature content, gambling, alcohol, crime and so on.

#### Norton ConnectSafe Policy A server addresses:

199.85.126.10	199.85.127.10
---------------	---------------

#### Norton ConnectSafe Policy B server addresses:

199.85.126.20	199.85.127.20
---------------	---------------

#### Norton ConnectSafe Policy C server addresses:

199.85.126.30	199.85.127.30
---------------	---------------



DNS.WATCH ([dns.watch](http://dns.watch)) provides free and unfiltered DNS servers. Its DNS servers are in Germany, which may mean some performance issues, depending on where you live. The provider promises not to log any DNS server requests or filter out any websites.

#### DNS.WATCH server addresses:

84.200.69.80	84.200.70.40
--------------	--------------



Comodo Secure DNS ([www.comodo.com/secure-dns](http://www.comodo.com/secure-dns)) provides free, fast DNS servers, which should be more reliable than your ISP's servers. In addition, Comodo's DNS servers will filter out any malicious sites, including those that house malware, phishing scams, spyware and excessive advertising. There's no configuration available: just switch your DNS servers to use Comodo's addresses and you're done.

#### Comodo server addresses:

8.26.56.26	8.20.247.20
------------	-------------

# How to change DNS addresses

Updating your DNS server address is pretty straightforward, and here we'll show you how to make the change on any device. The best method is to alter your router's settings, as this will change DNS server settings across your entire network

## Change your router's settings

Most routers should let you alter the default DNS server addresses through their configuration page. This will affect every device that uses your router to connect to the internet, making it the easiest way to change DNS servers if you have more than one internet-enabled device in the home.

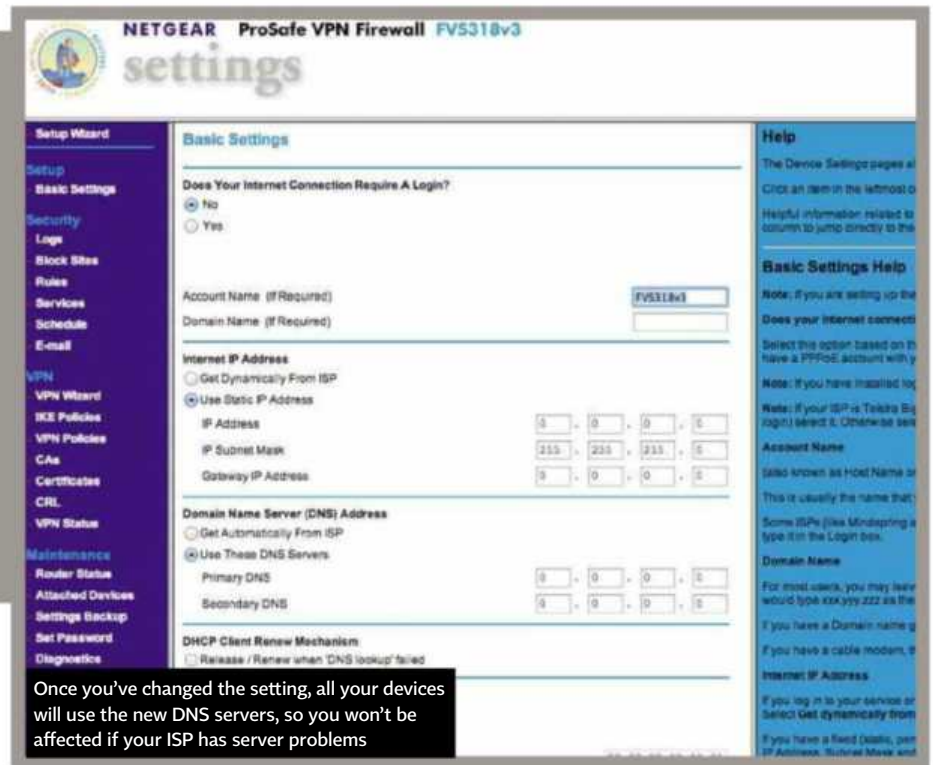
Unfortunately for BT Broadband customers, this isn't possible on a BT Home Hub, meaning you'll have to follow our on-device DNS settings guide (below).

Connect to your router's web-based management page and log in. Look for the section that contains your router's internet (WAN) address, and you should be able to override the DNS server setting. Enter the new DNS addresses; for Google, these are 8.8.8.8 and 8.8.4.4.

## Change on device

If your router doesn't let you change DNS servers, such as with the BT Home Hub, you can manually change DNS servers on each internet-connected device. It takes a little more time and effort, but by the end you'll be able to get online without worrying whether your broadband provider's DNS servers are up and running.

If you're having problems connecting to the internet, it may be worth changing one device in your home, so you can check if the error is due to a DNS problem or because your entire connection has gone down.



## Windows

If you have a Windows laptop or desktop computer, you'll need to open the Control Panel. Windows 8 users can hit the Windows key and type Control Panel, while older versions of Windows have a Control Panel shortcut in the Start menu. From here, click Network, Sharing

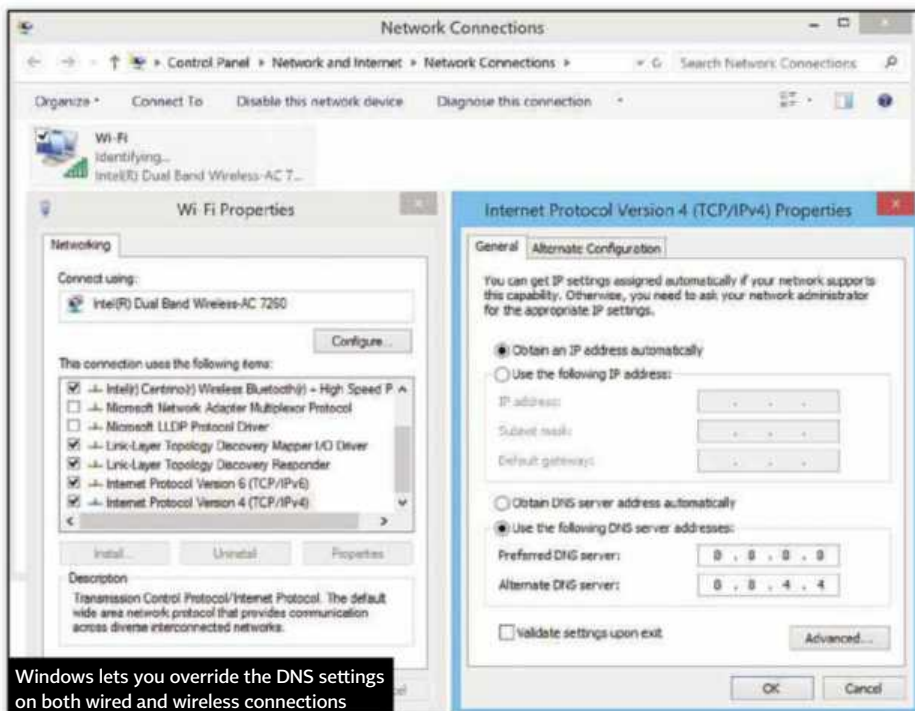
Center, then Change adapter settings on the left of the window that opens. Next, right-click the connection you use to get online and select Properties. We've used Wi-Fi, but if you use a cable click Ethernet instead.

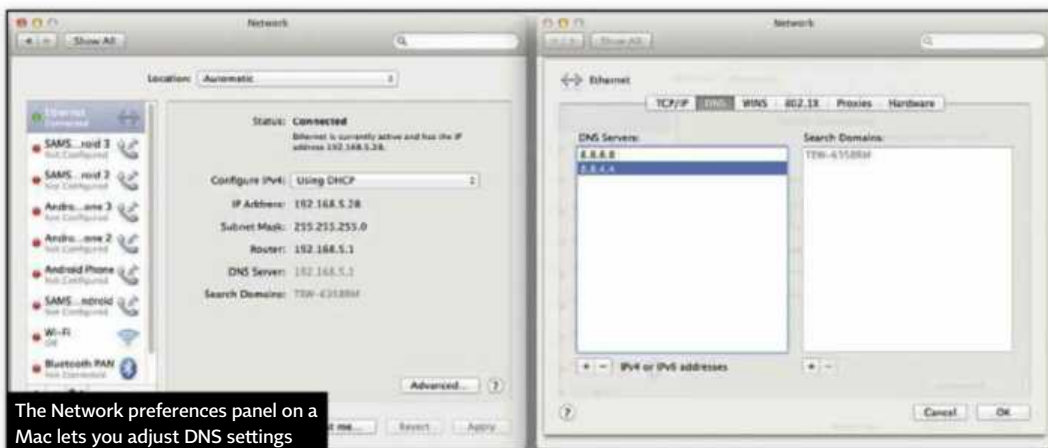
You should see a list under the heading 'This connection uses the following items'. Select Internet Protocol Version 4 (TCP/IPv4) and click Properties. In the window that opens, change the radio button from 'obtain DNS server address automatically' to 'Use the following DNS addresses'. Enter the Google DNS servers (8.8.8.8 and 8.8.4.4), hit OK, and click Close on the previous window.

## Mac

If you're using an iMac desktop or MacBook laptop, simply click on the System Preferences icon in the dock then click on Network in the window that appears. Make sure the active network interface is selected (in our case it was Ethernet, but if you're connected over wireless make sure to choose Wi-Fi) then click Advanced... in the bottom right-hand corner of the window.

From here, select the DNS tab and hit the + icon at the bottom left of the window. Add the Google DNS server addresses (8.8.8.8 and 8.8.4.4), then hit OK to save your changes. Click Apply and you're done.





The Network preferences panel on a Mac lets you adjust DNS settings

## iOS

For Apple mobile devices you need to be connected to your home Wi-Fi network. Go to Settings, Wi-Fi and then tap the 'i' next to the network to which you're currently connected. Go down to DNS and tap the field to edit the information that's listed. Enter, '8.8.8.8, 8.8.4.4' (including the comma, but excluding the quote marks). Tap Wi-Fi at the top of the settings page to go back and apply the changes.



## Change with DHCP on a NAS

If your router won't let you change DNS addresses, but you don't want the hassle of changing every single device on your network, you might be able to save some time using your NAS drive. Many models can take over from a router, handing out IP addresses to your connected devices and controlling, therefore, which DNS servers are used. We've used a Synology DiskStation in our example, but other NAS devices have similar options.

First, open the NAS interface by typing its web address into your web browser, then logging in using your administrator or user account information. Your NAS has to have a static IP address, so go to Control Panel, Network, Network Interface, click LAN and select Edit. Click IPv4 and select Use manual configuration, then enter a safe static IP address. To do this, connect to your router and look at its DHCP settings to find the first

and last IP address it gives out and note down these numbers. Next, pick an IP address outside of this range, which you'll use for your NAS. Enter the subnet mask as 255.255.255.0. Click OK; you may have to reconnect to your NAS using the new IP address you've given it.

Once you're back in the management console, the instructions differ depending on the version of the Synology NAS you're running. Only devices that have DSM 4.2 or higher installed (roughly 2009 and onwards) can run the DHCP server. For DSM 4.X devices, you have to install the DHCP server package using package manager, then run it from the Menu. DSM 5.x devices shouldn't need the package installing; the settings are in Control Panel, Network, Network interface, then

click your LAN adaptor and click Edit, then click the DHCP server tab. Note that you can't use the DHCP server if it has more than one network adaptor and it's in Bridge mode. Both the DSM 4.X and 5.X versions have the same settings once you're in.

Select Enable DHCP server, then enter the Primary DNS as 8.8.8.8 and the Secondary DNS as 8.8.4.4. Click the Add button, then under Start IP address enter the same start address as used by your router, and the end IP address as your router's end address. Enter the Netmask as 255.255.255.0 and the Gateway as your router's IP address. Click the Enabled tick box and click OK.

Now connect to your router's web-based management page, find the DHCP server settings and disable the DHCP server. Apply your settings and any device that connects to your network will have new DNS and IP address settings given out by your NAS.

## Android

For smartphones and tablets running Google's mobile operating system, jump into the Settings menu and head for the Wi-Fi section. Make sure you're connected to your local Wi-Fi network, then press and hold its network ID to bring up a text box. Select the second option - Modify network config - and tick the 'show advanced settings' tickbox in the new window that appears. Now change the IP Settings dropdown box from 'DHCP' to 'Static'. Enter a safe static IP address (see 'Change with DHCP on a NAS', below).

You'll then need to scroll down the page until you see two text boxes labelled DNS 1 and DNS 2. Put the two Google DNS server addresses (8.8.8.8 and 8.8.4.4) in these boxes and hit Save to finish.



# The ultimate guide to YouTube

Simply watching videos on YouTube is just scratching the surface of what's on offer. Here we show you how to make the most of the popular video-sharing service



YouTube is big. Really big. Every minute, 300 hours of video content is uploaded to YouTube. It's a mind-boggling statistic that highlights the struggle many new users have when joining a sharing network, when they can feel utterly overwhelmed with the amount of content that's available; it's a case of not being able to see the wood for the trees. The videos you want are there, but how do you find them? We'll show you how to find them, and how to make YouTube a daily destination when you fancy something to watch.

What's more, an entire industry has been revolutionised by YouTube. Bedroom video bloggers – vloggers – are earning six-figure sums and upsetting the Hollywood apple cart, producing sensational video after sensational video at a fraction of the cost of a TV show. Over the next few pages we'll show you how to get in on this goldmine, or just share a few clips with your friends and family. We'll also explain YouTube's editing tools and how to manage your channel to best effect.





17:04

**The Best Of Vocal Deep House Chill Out Music 2015**  
by DiRegard Official  
184,269 views • 2 weeks ago

8:13:33

**Best of Beethoven Classical Music for Relaxation**  
by Classical Music  
1,656,592 views • 2 years ago

1:30:47

**Mojito Lounge Beats | Deep & Tropical House Session**  
by Chill House Mix  
32,873 views • 3 months ago

3:00:11

**3 Hour Focus Music: Study Music, Alpha Waves, Calm...**  
by YellowBrickCinema  
2,431,722 views • 11 months ago

1:07:29

**1 Hour of Epic Space Music: COSMOS - Volume 1 | GRV**  
by Mortifer V.  
124,262 views • 6 months ago

11:24

**GP BTCC 2015**  
by BTCC  
2,482 views • 1 week ago

1:24

**LEGEND | BTCC 2015**  
by BTCC  
2,482 views • 1 week ago

1:59

**BRANDS HATCH GP LAP RECORD | BTCC 2015**  
by BTCC  
1,572 views • 1 week ago

0:43

**WATCH THE BTCC 2015 GRAND FINALE ON ITV4**  
by BTCC  
2,389 views • 1 week ago

4:30

**POWER MAXED RACING SILVERSTONE REVIEW |...**  
by BTCC  
593 views • 1 week ago

16:17

**SILVERSTONE EXTRA | BTCC 2015**  
by BTCC  
926 views • 2 weeks ago

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50+ VIDEOS

**Kennedy Plays Bach: The Concerto**

vevo

3:29

**Taylor Swift - Our Song**  
by TaylorSwiftVEVO  
103,889,317 views • 6 years ago

50+ VIDEOS

**My Mix**  
by YouTube

50+ VIDEOS

**Mix - Moonlight Sonata - classical guitar**

vevo

5:04

**Taylor Swift - Fifteen**  
by TaylorSwiftVEVO  
93,657,327 views • 5 years ago

vevo

3:5

**Taylor Swift - Wildest Dreams**  
by TaylorSwiftVEVO  
136,638,261 views • 1 month ago

Game Reviews

**COIN USHERS**

**UNDERTALE**  
LGR QUICKIE

**LGR Thrifts**

**LGR Plays**

**AVRAMELIA AUDIO**

**Beyond City**

Search channels



#PopularOnYouTubeUnitedKingdom

The pulse of what's popular on YouTube - United Kingdom. Take a look at trailers, comedy clips and everything else that people are watching.

All changes saved.

Search videos

Video editing toolbar with icons for video, copyright, photo, music, play, and text.

Grid of video thumbnails:

- [SR] Head to Hea... 6:38
- The Blame Game... 0:48
- The Blame Game... 2:16
- Sniper Attack 0:29
- Use the Force 4:30
- The Blame Game... 2:33
- The Blame Game... 2:03
- The Flip 9:57
- Remote Control C... 9:30
- 0:20
- 2:09
- 2:26
- 1:01
- 0:29



# YouTube video page features

You'd think watching videos on YouTube would be the simplest part of the website. This is true to an extent, although the YouTube player is more powerful than many people give it credit for. Here are some of the useful things it can do

**1 BASIC CONTROLS** Play and pause the video, and control the volume from here. Note that you can also pause the video by clicking anywhere in the player.

**2 PLAY LOCATION** This shows you how much of the video has played.

**3 BUFFER LOCATION** How much of the video has been loaded in the quality you have selected. If the red bar meets the white bar, the video will stop and buffer. Even if your internet speed is fast enough to load the video in a few seconds, YouTube limits the amount of the video it buffers at a time to save bandwidth.

**4 SUBTITLES** This button switches subtitles on and off if they're available.

**5 SETTINGS** From here you can configure the YouTube player to your liking.

**6 AUTOPLAY** A feature recently added by YouTube. If this is enabled, when you finish the video a new one will automatically play 10 seconds later. This can be annoying if you want to take the time to look at something else or change tabs, but it's also a great way of sucking you into a long YouTube binge.

**7 ANNOTATIONS** Annotations are like sticky notes that video creators can place on their videos after they've been uploaded. They can be used to clarify statements, make corrections and can also be used to link to other videos and external websites. Professional video creators use these sparingly and effectively, but you should take them with a pinch of salt elsewhere; they can often be misleading and obstruct the video.

**8 SPEED** Lets you change the playback speed from one-quarter to double the original speed. Especially handy for videos with fast action that you want to slow down, or very long videos, such as podcasts, that you want to get through quickly.

**9 SUBTITLES SETTINGS** Subtitles on YouTube are powerful. The best content creators will upload their own scripts to

YouTube, and YouTube's own speech-to-text software will accurately sync up the script with the video's dialogue. For videos uploaded without subtitles, YouTube will automatically generate them, with varying degrees of accuracy. You can also get translations in a wide variety of languages and customise exactly how subtitles appear, including colour, size, highlights and font.

**10 VIDEO QUALITY** YouTube automatically chooses the video quality it thinks is suitable for your current connection speed. If this proves to be too much or you reckon you have more bandwidth than YouTube is offering, you can switch between various video sizes, from 240p all the way up to 4320p (8K). Some videos are also available in higher frame rates, with HD content available at 60fps instead of the standard 30fps.

**11 SIZE TOGGLE** By default, YouTube videos appear as small boxes that take up a quarter of the screen. Click this button to enter Cinema Mode, which fills most of your browser window and also adds a black surround. Click again to go back to Default.

**12 FULL SCREEN** Click here to go to full screen. If you have high enough bandwidth, YouTube will increase the quality of the video to the maximum resolution of your screen, so if you have a Full HD screen, YouTube will show you Full HD video.

**13 EXTRA INFORMATION** Some videos may refer to other items and videos on the web. Instead of using clunky annotations, these can be added to a menu that you can open at any time.

**14 CHANNEL INFORMATION** The name, profile picture and number of subscribers for the channel whose video you're watching. The grey tick means the user has been verified by YouTube as a trusted producer.

**15 VIEW COUNT AND LIKES** The number of views the video has received (updated every few hours) and the number of likes and dislikes. Likes are a great

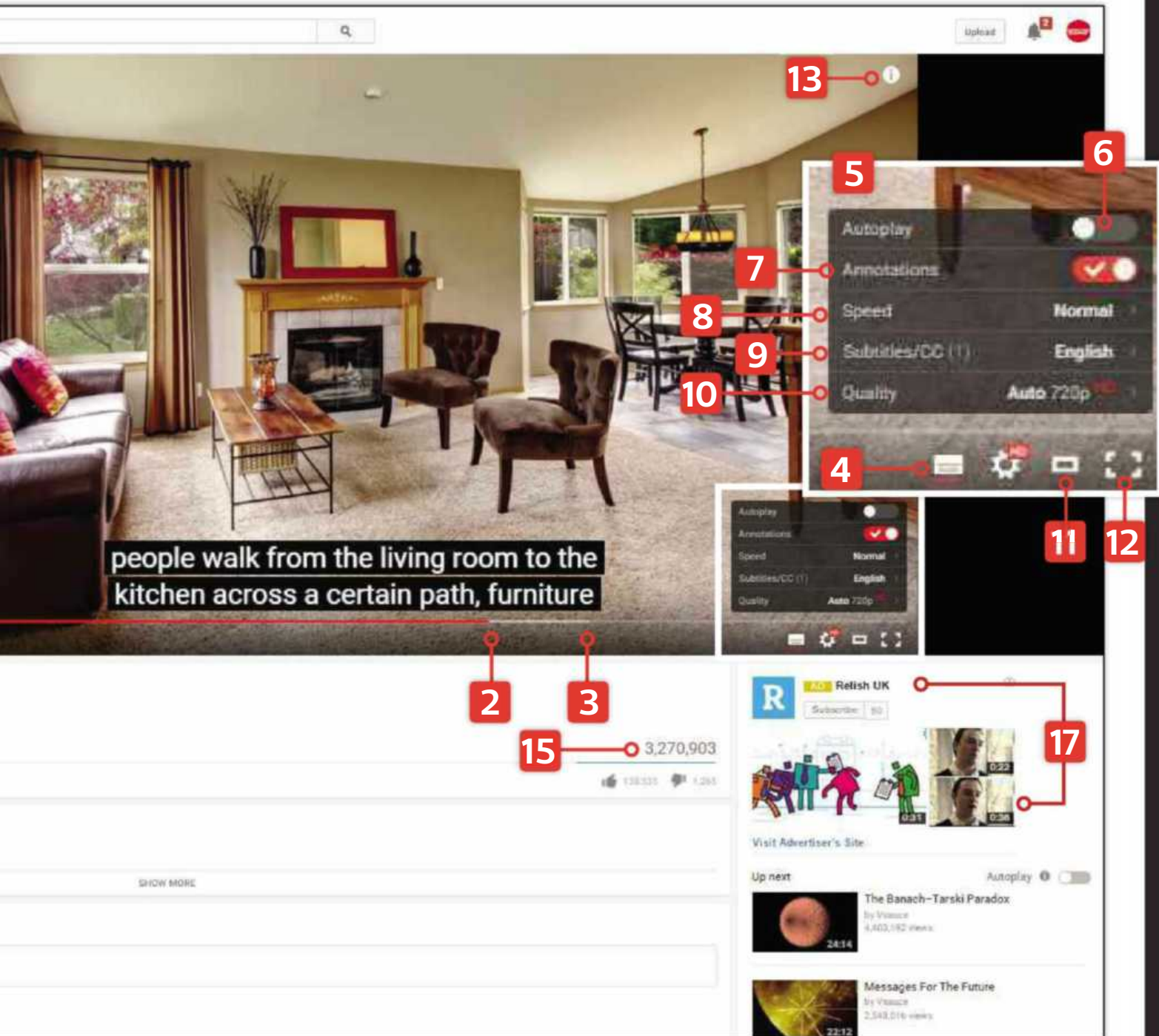


way of evaluating a video's relevance before watching it. If a video has a high number of dislikes, it's probably not worth your time.

**16 DESCRIPTION** Information about the video and links to other sources are placed here. Click the Show More button to see it in its entirety.



# explained



**17 ADVERTISEMENTS** If you were shown an advertisement before the video started, you can refer to it any time from this small module under the video and visit the advertiser's website if their product actually interests you. The link will open in a new tab so you won't lose where you are.

**18 COMMENTS** User comments from other users. Often a place to avoid, as the quality of the discussion rarely adds to the video itself, especially on very popular videos, where the discussion usually consists of spam and personal insults. A voting system tries (and often fails) to keep the best comments at the top.

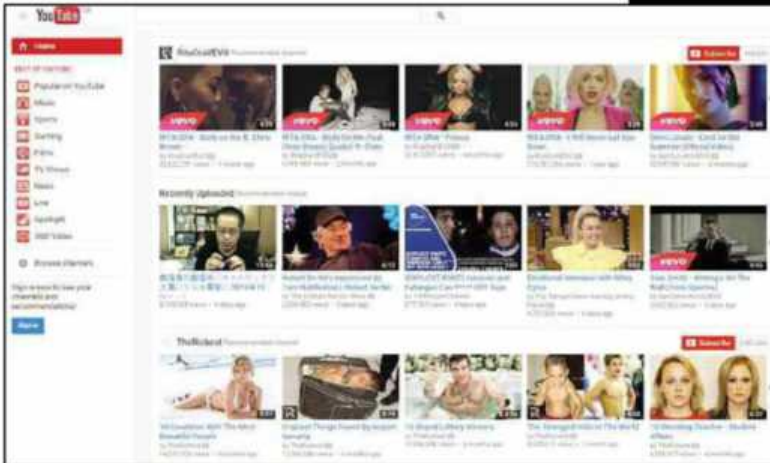
**19 SHARE BUTTON** Lots of options are hidden behind the share button, including generating links that start the video from a specific point, embedding the video using HTML and even generating an animated GIF file to share snippets with friends. You can also choose almost any social network you can think of to share the video on.



# Finding channels to subscribe to

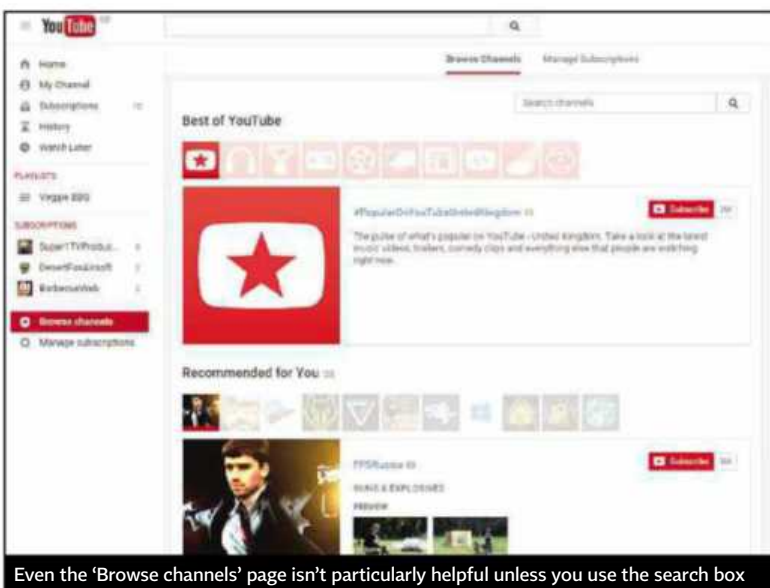
**IF YOU GO** to the YouTube homepage as a new visitor, you'd be forgiven for wanting to close your tab and never come back. You're presented with a selection of the most popular content of the day and a selection of promoted content that includes Justin Bieber and a clickbait-heavy channel called 'TheRichest', which includes video gems such as "10 Men You Won't Believe Exist" and "People That Took Bodybuilding To The Extreme". Truly mind-numbing.

With such a depressing range of videos, who can blame you for backing away from YouTube's homepage?



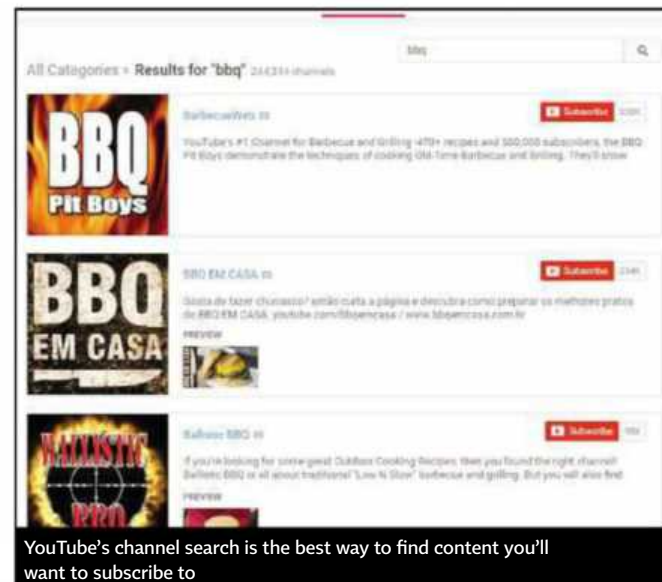
And yet, buried beneath is a network of quality content that will suit pretty much every taste and interest. YouTube doesn't make it easy to try to suggest content you'll actually like when you first sign up; you can't give it a set of interests and keywords and receive recommendations.

Once you've built up a modest list of subscriptions and watched a few videos, your homepage will look almost unrecognisable as YouTube gets into gear, trying to find content it thinks you'll want to watch.



When you first visit YouTube with your new account, the best way to find channels that relate to your interests is to click on the 'Browse channels' button on the left-hand side of the page. If you can't see it, click the three horizontal lines next to the YouTube logo at the top of the screen.

The Browse channels page isn't particularly helpful by itself, as it will still suggest a vague set of categories you probably aren't interested in. Instead, click in the search box labelled 'search channels' and type in whatever topic you want to explore. Searching for 'BBQ', for example, brings up a selection of channels. Each channel has a Subscribe button that also shows you how many subscribers a channel has, and you'll also be given one or two videos to preview so you can see whether you actually like the content the channel produces without having to navigate away from the search page. If you like what you see, you can press the Subscribe button.



If you then navigate to that channel, YouTube will suggest other similar related channels in the sidebar on the right, letting you find plenty of interesting channels.

After subscribing to a few channels and watching some videos, you'll find your YouTube homepage looks very different. You'll get a mix of suggested content from channels you subscribe to, and others you don't.

## FAVOURITES, PLAYLISTS AND HISTORY

There are multiple ways to keep track of the videos you've watched on YouTube. Any video you watch will be added to your History. It can be cleared at any time, and you can also pause your History indefinitely if you don't want videos you're about to watch to be included. Usefully, YouTube will remember whether you finished a longer video or not, and will start you back from where you left off.

YouTube has removed the ability to add videos to a list of favourites. However, you can create your own private playlist of favourite videos. To do this, click the 'Add to'





You can make a playlist called 'Favourites' to add videos you want to watch later

button beneath any video and create a new playlist called Favourites for your unsorted videos you want to keep track of. Set the playlist to private.

You can also create themed public playlists to share with others using the above method. For example, if you want to share a list barbecue recipes for an upcoming event, you can add the videos you want and then share the entire set.



Hover your cursor over any video thumbnail to reveal the Watch Later button

If you find a video you want to watch but don't currently have time for, you can add it to your Watch Later playlist. To do this, hover your cursor over a video thumbnail and click the clock icon. You can also add it to a playlist. Hover your cursor over the video and click the three dots on the right, then add it to a playlist, as above. Once you've made a playlist, it will appear on the left of the YouTube homepage for easy access.

### MAKING PLAYLISTS WORK FOR YOU

A playlist is a lot more than an ordered set of videos and, if set up correctly, can be put to work for you. Go to any playlist you've made and click Playlist settings. Here, you can change basic settings, share with others to allow them

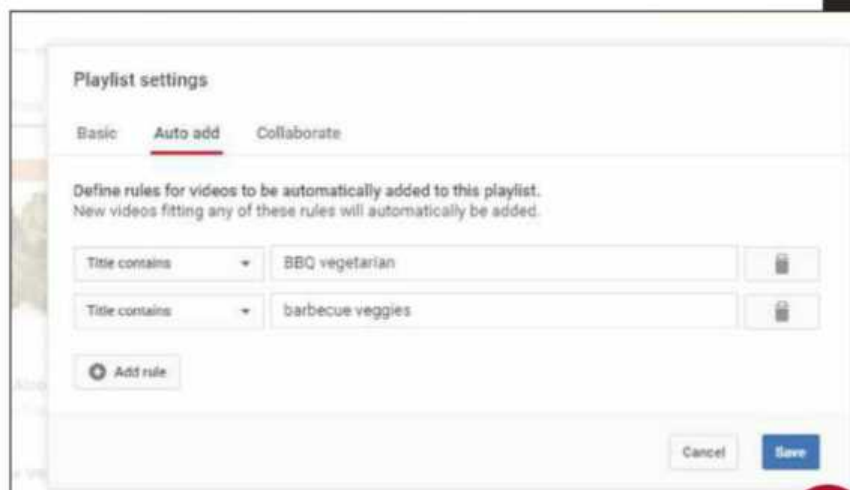
**“ Buried beneath the mind-numbing dross on the YouTube homepage is a network of quality content that will suit pretty much every taste and interest ”**

to add videos, and set up automatic adding of videos relevant to the playlist. This is a handy way of getting content you're interested in delivered to you, without having to subscribe to multiple channels and hoping they provide you with the exact content you want.

Use this tool carefully, as there's no option to limit the number of videos that get added to your playlist, so if your terms are too wide you'll end up with a deluge of videos that you'll never have time to watch. You can add filters for video titles, descriptions and tags. Tags are invisible to everybody but the creator of a video, so this particular filter is useful only if you run your own YouTube channel and want to add your own videos to playlists automatically.

You can add multiple filters but, again, be careful not to add too many; YouTube doesn't expand your filter in the same way Google does with web searches; if you add a filter for 'BBQ', for instance, you won't get results for similar words such as 'barbecue'.

If you find a channel that you watch regularly, you can show your appreciation in the form of a monetary tip. Head to the channel's page and, if it has tips enabled, you can send any amount of money you desire to show your support. You may not get anything in return, though, aside from a warm, fuzzy feeling.



You can make YouTube automatically add certain videos to playlists

# Making YouTube less annoying

**WHILE YOUTUBE IS** an incredible tool and a website that can genuinely replace your Netflix subscription, it's not perfect. From unskippable adverts to requiring a persistent internet connection, we've come up with five fixes to the website's most irritating niggles.

## WATCHING VIDEOS OFFLINE

Having to be constantly connected to the internet to watch videos can be a pain, especially if you're on a long trip, for example. There are a couple of ways around this, but both have their limitations.

First, the catch-all, dubious method: to download any video for offline playback, simply copy the URL of the video you want and go to [keepvid.com](http://keepvid.com). Paste the URL into the box at the top of the page and click Download. The second method is only available using YouTube Red (see below).

You'll be presented with a list of download options in KeepVid, but most of them limit you to audio or video only. The top two options are generally the best bet, providing you with 480p or 720p-quality MP4 files that have both audio and video, or select one of the MP3 links instead. Avoid any other download buttons littered around the page: these are ads that will try to make you download software. You need no extra software to download a KeepVid video.

## REMOVING COMMENTS

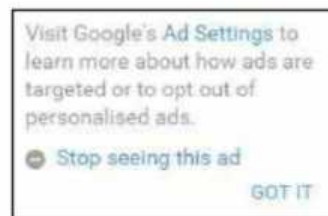
YouTube comments can really spoil your enjoyment of a video, with biting criticism, petty arguments or spoilers. Luckily, there are extensions available for Google Chrome ([tinyurl.com/hideyoutubecomments](http://tinyurl.com/hideyoutubecomments)) and Mozilla Firefox ([tinyurl.com/hideyoutubecommentsFF](http://tinyurl.com/hideyoutubecommentsFF)) that simply remove the module where comments are normally found.

## BLOCKING ADS

In order to fund content, YouTube has to show ads, known as 'pre-rolls', to users when they come to a video. Some of them can be more than five minutes long, although these

truly epic ads usually give you the option to skip after five seconds. These ads are also starting to show up in longer videos, with ads being shown every 10 minutes.

If you're shown an ad you can't skip and you don't like it, simply hit refresh and you'll be given another, different ad. You might even get one you can skip sooner.



YouTube lets you block individual ads if you find them annoying

If you keep getting the same ad repeatedly, you can permanently block it. To do this, click the small 'i' button at the bottom-left of the video and click 'Stop seeing this ad'. This will also skip the current ad and take you straight to the video. It's not clear how often you can do this, though.

## FIXING STUTTER AND LAG IN GOOGLE CHROME

Viewers with slower computers often complain about YouTube videos streamed at 60fps instead of 30fps, and others have problems playing HD video without stuttering. A simple fix that many users have found works effectively is to disable hardware acceleration in Google Chrome. To do this, go to Settings and search for 'hardware acceleration'. Untick the box and you should see improved performance.

An alternative solution for Chrome users can be found at [tinyurl.com/chromeh264](http://tinyurl.com/chromeh264). This extension forces YouTube to serve video in the H.264 codec instead of VP8/VP9, which can improve performance in some cases.

## PREVIEWING VIDEO RATINGS

YouTube isn't in the habit of serving up videos it thinks you'll hate, but sometimes it's nice to know that you're about to watch a video that you'll probably enjoy. The YouTube Ratings Preview extension, found at [tinyurl.com/YTratingspreview](http://tinyurl.com/YTratingspreview) is a handy extension for Google Chrome that adds the blue/white bar to the thumbnail of every video link on every page on YouTube.

The extension has lots of customisation options, including colour, size and an option to highlight the best-rated videos on any given page. It's a must-have for any avid YouTuber.



## YouTube Red

In October, YouTube announced YouTube Red, a premium subscription service that adds a lot of new features, many of which solve the problems discussed above.

Aside from a selection of premium content available exclusively to subscribers, you also get a set of features that improve the YouTube experience. First, you get ad-free viewing, which means you'll never see another ad on any video you watch.

Next, you can download videos to watch offline on your smartphone or tablet later, which is a huge boon when you're going to be away from your Wi-Fi connection. Finally, you can continue to play videos in the background even if you navigate away from the YouTube app.

A YouTube Red subscription also gets you access to Google Play Music, which currently costs £9.99 alone. In the US, YouTube Red will cost \$9.99, which is around £6.50, but UK pricing and availability has not been announced; don't be surprised if the UK price ends up being closer to £9.99.



# Making YouTube child-friendly

**ALTHOUGH YOUTUBE IS** home to some many child-friendly video-makers, you should still supervise your children when they're browsing the site. There are currently no catch-all ways of stopping objectionable content – whatever you view that to be – from making it on to your kids' screens. There are a few ways to make things a bit safer, though, which we'll explain here.

## ENABLE RESTRICTED MODE/SAFETY MODE

The best method to block most objectionable content is to enable Restricted Mode, which is also sometimes referred to as Safety Mode. Full details on how to enable Restricted Mode can be found on YouTube's help pages ([tinyurl.com/YTrestrictedmode](http://tinyurl.com/YTrestrictedmode)), but it's also worth explaining exactly where Restricted Mode does and doesn't work.



According to YouTube, Restricted Mode uses “community flagging, age restrictions and other signals to identify and filter out inappropriate content”. In other words, and unsurprisingly, videos aren't manually vetted to see if they're suitable for kids, so you're relying on the YouTube community and Google's algorithms to block content you don't want your child seeing. YouTube makes it very clear that it's not 100% reliable. You have been warned.

It's easy to flout these restrictions, too. While unsuitable content is unlikely to show up next to popular kids' content,



Stampy is a child-friendly Minecraft player

Restricted Mode doesn't disable the search function, nor does it block videos that have bad language or potentially offensive jokes. More easy-to-spot terms are blocked; search for videos of the game Call of Duty, for example, and while you'll get a full list of search results, the vast majority of the videos will be blocked as the game in question is for mature audiences.

One area where this is very clear is the world of Minecraft videos, which are very popular with children. There are some huge kid-friendly Minecraft YouTube channels, such as Stampy, which are very careful to avoid swearing. Conversely, the Yogscast, which also focuses heavily on Minecraft, doesn't censor swearing or adult content, but remains mostly unblocked by YouTube Restricted Mode. YouTube continues to show advertising for alcohol products when Restricted Mode is enabled, too.

Additionally, when you enable Restricted Mode in your web browser, you should ensure you click 'Lock Restricted Mode for this browser'. This means you can log out of your account and still restrict other users of the browser. There is a workaround for this, and if your children are particularly clever, they can open a new Incognito window, which disables Restricted Mode. In short, Restricted Mode is not a replacement for supervising your children.

## WHERE TO START

*Computer Shopper* is not a parenting magazine, but there are plenty of online resources that claim to be, many of which have handy lists of YouTube channels suitable for younger kids. These include Common Sense Media, which has lists of YouTube channels with videos suitable for various ages ([tinyurl.com/YTforkids](http://tinyurl.com/YTforkids)).

The site also keeps a list of popular Minecraft channels ([tinyurl.com/YTminecraftkids](http://tinyurl.com/YTminecraftkids)), with added information about how complex the videos are and whether they're suitable for very young viewers.

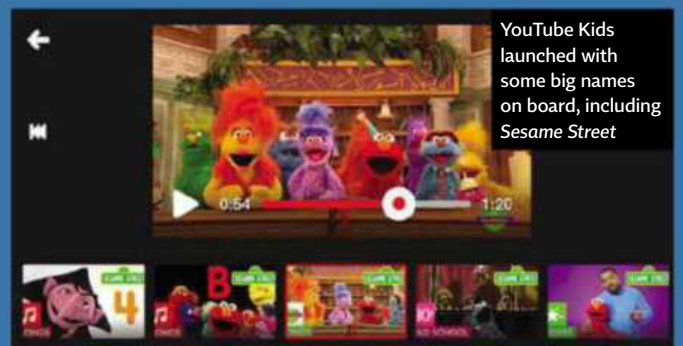
## YouTube Kids

To illustrate how big the child market is to YouTube, you only have to look at the numbers. In September (the most recent viewing figures available at the time of going to press), five of the ten most-viewed YouTube channels were aimed at children, with toy reviews, cartoons, sing-alongs and video blogs dominating the world's viewing habits ([tinyurl.com/YTsept15](http://tinyurl.com/YTsept15)). Four were music channels, and the other was BuzzFeed.

It comes as no surprise, then, that YouTube is cashing in. In February 2015, the website launched YouTube Kids, an app

for Android and iOS devices that curates family-friendly content into an easily digestible and searchable package.

Currently, the app is available only in the US, but its first eight months on the scene have been trying to say the least, with accusations of unlabelled sponsored content chief among the issues that were brought to the attention of the US Federal Trade Commission. Channels from the likes of McDonald's, Fisher Price and Lego all got a fair amount of promotion, with other companies also receiving product placement spots in



video reviews of toys. This isn't new – cartoons with branding messages have been around for decades – but with a more enlightened audience and more suspicious parents, YouTube has a challenge on its hands.

The app does have some useful features for parents, including time limits, a volume limiter and the ability to disable the search function and only allow children to watch content promoted in the app.



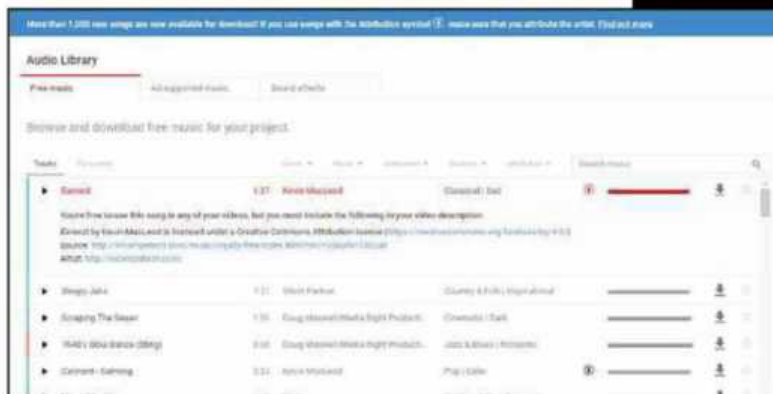
# Making money and free content

**IT'S OFTEN SAID** that the internet has democratised creativity, and there's no better example of this than YouTube. If you've not looked at YouTube's Creator Tools for a while or have never dared venture into the world of creating your own videos, it's well worth a look. Here we'll show you how to use content supplied by YouTube to make your videos sound and look great without paying a penny. We'll also explain how advertising on YouTube works, and discuss what your chances are of making the big time.

## USING ROYALTY-FREE MUSIC

YouTube now lets video creators use copyrighted music in their videos. Previously if you used copyrighted music (generally popular music from the big record labels), you would lose the ability to make money from your videos and could even get a strike on your account, which prevents you from making any money in the future.

YouTube makes it very clear how you should credit royalty-free music providers



YouTube now makes it easy to see what copyrighted songs you can use in your videos, although you'll still need to own the track itself in order to use it in your videos. To find out what music you can use in your videos without running into problems, click My Channel on the left of the YouTube homepage, then Video Manager at the top. Finally, click Create on the left, and you'll end up at the Audio Library ([tinyurl.com/youtubeaudiolib](http://tinyurl.com/youtubeaudiolib)) page.

Three tabs separate the three types of audio YouTube makes available. On the Free music tab, you're given a list of tracks you can use for free, and a button to download each one. Some tracks require you to credit the artist when you use them; details are available next to each track.

## COPYRIGHTED MUSIC

Click the ad-supported music tab in the Audio Library menu, and you'll see a full list of all the commercial music you can use. You can search for tracks or artists in the search bar. When you've found a song you want to use, click it and you'll be told what you can expect to happen if you use the video. Most copyrighted songs will result in pre-roll ads being shown on your video, and many of them will take all the revenue from the ads shown.

## FREE SOUND EFFECTS

YouTube also has a reasonably large library of sound effects. Not all of them are particularly good, in fact very

If you perform covers of famous songs, some artists will split their ad revenue with you. Psy's Gangnam Style is one example



few seem to be of notable quality, but they're useful if you don't want to shell out on a collection. As with music, you can search, favourite and download different sound effects. Unlike music, however, you don't have to give credit for them, so you can use as many as you like in your videos.

## MAKING MONEY ON YOUTUBE

You'll have read stories about the world's biggest YouTube stars earning six-figure sums from YouTube from views alone, raking in even more cash with product-placement deals, events and even movie deals and music albums.

These YouTubers didn't do it on their own, however. Backed by large production studios with dedicated teams working on sponsorship deals for video adverts and product placement, behind every great YouTuber is a team of people making it happen.



This means that the standard video pre-roll adverts are not the main source of income for the biggest stars. It's the bespoke content and self-sourced advertisers that bring home the bacon, not automatically assigned video ads. However, it's still possible to make money from YouTube, although when you'll actually start raking in the bucks will depend on how popular your videos become and a whole heap of luck. Often, it's the unexpectedly viral cat video among thousands of similar clips that will rise above the rest and start gaining millions of views.

To give yourself the best chance of hitting the big time, use non-copyrighted music, ensure your videos aren't in breach of YouTube's policies and make sure that you've edited them to perfection (see opposite) so people will want to share them with friends and family.





# Editing your videos

**IF YOU HAVE** a clip you're dying to share but don't want to shell out on video-editing software, you can use YouTube's rudimentary web-based video editor to cut your clip down to size and spruce it up, ready for the world to see.

## UPLOADING YOUR VIDEO

If you recorded your video on a smartphone, you can upload directly from the YouTube app. On Android, select the tab on the right of the main screen and tap the up arrow to upload. On iOS, you'll find the upload button in the menu that pulls in from the left of the app.

Once uploaded, you'll need to go to a desktop web browser to fine-tune your video. Click your YouTube profile picture, then click Creator Studio. Select Create on the left, then Video Editor. You'll be presented with a blank timeline, a preview window and a box that contains your uploaded videos. If you want to combine more than one video, you can do this here. To start, click and drag a video from the library to the timeline. This will include both the video and the audio track. There's an extra audio track for background music if you choose to use it.

## SLICE AND DICE

If the best part of your video is several minutes in, don't make people sit through the whole thing: cut the video so the money shot is front-and-centre. This is simple but important: people aren't going to wait around for a punchline, and are less likely to share a video that requires effort. Short, sharp, immediate content is king on YouTube.

When you first drag a clip to the timeline, you can use the handles on the left and right of the clip to trim it to size. If you want to trim it again in the future (or extend it back to its original length), click the video on the timeline again and drag the handles around.

## QUICK FIXES

The Auto-fix tool applies contrast and brightness settings, and also stabilises the footage. You can apply other fixes individually, and also add slow motion to your clip.

The other tabs let you apply filters and add captions to the video, which can be handy if you're trying to explain what's going on. Finally, a set of audio adjustments are available to make certain sounds clearer. You can keep on adding videos to the timeline to trim and adjust in the same way you did with the first clip. Then you can move on to some of the other tools available.


If stills tell your story better than a video can, you can use photos instead. Upload them through the photos tab and drag them on to the timeline as you would a video. To make them look a little more interesting, add a pan zoom from the Quick fixes tab so you're not just showing still image after still image.

## MUSIC BOX

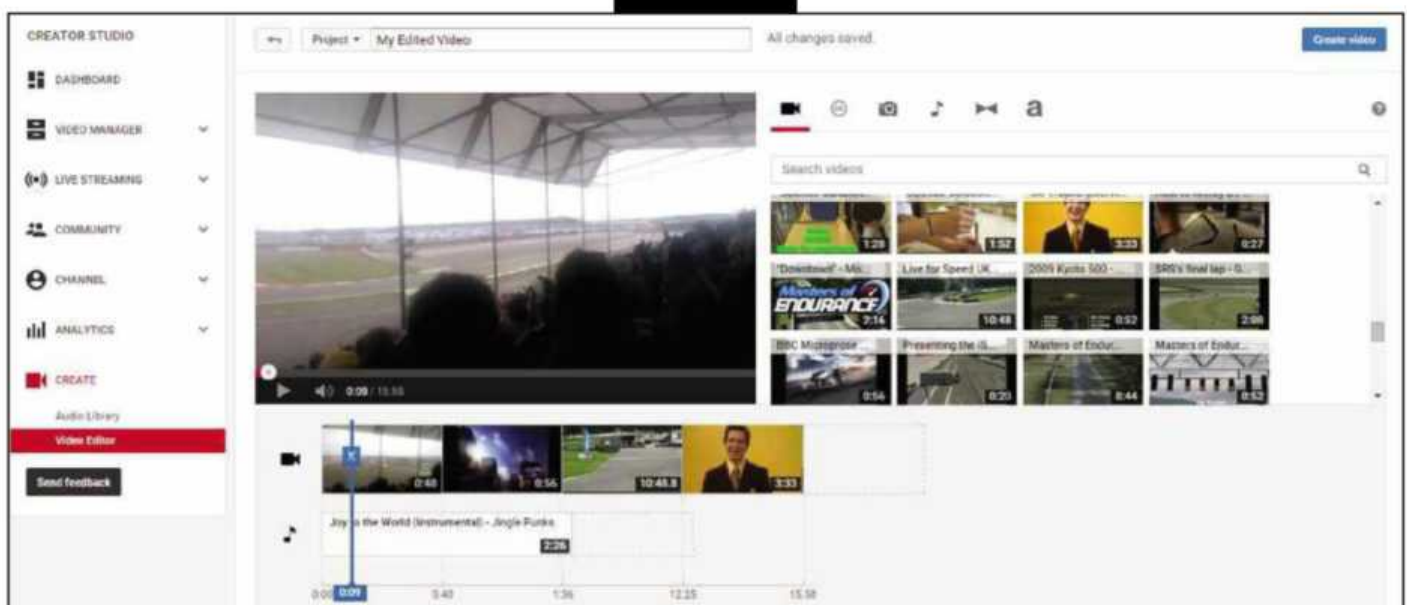
You can add background music in the music tab. Drag any song to the audio section of time timeline. You can adjust the volume by clicking the track in the timeline and adjusting the volume slider. All the music in the music tab is available for free, although YouTube doesn't notify you whether you need to credit the musician or not. It will be worth noting down the track and artist name and adding it to your video's description when it's published.

The transitions tab lets you add fades and wipes to your video. Select a transition and drag it to the timeline, to any point in the video where two items meet. This will add a smooth transition between clips. You can also drag transitions to the start and end of the video.

## FINISHING UP

When you're done with your video, hit the blue Create Video button on the top right of the screen. You'll then be taken to the video's page. You'll see an error message because YouTube will still be processing the video. After a few minutes, the video will be live and viewable. You can edit the description of the video here, and also edit whether the video is private, public or unlisted, which means only those with the link can watch the video; it won't show up in search results or on your channel. 

The YouTube video editor is the best way to fine-tune simple videos without having to deal with complex desktop software



28:45/30:00

HD



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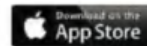
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# Business Help

If you have database, office application or macro issues, **Kay Ewbank** can help. Send your problems to [businesshelp@computershopper.co.uk](mailto:businesshelp@computershopper.co.uk)



## Word table won't break across pages

**Q** I have a table in Word that should be longer than a single page. I've set it to break across pages using Table Properties, Row, Allow row to break across pages, but it doesn't. It used to work in Word 2007 but I've tried it in both Word 2010 and Word 2013, and it won't break across pages. It occupies the entire page, but there are many rows missing at the bottom of the table. What's going wrong?

David Wear

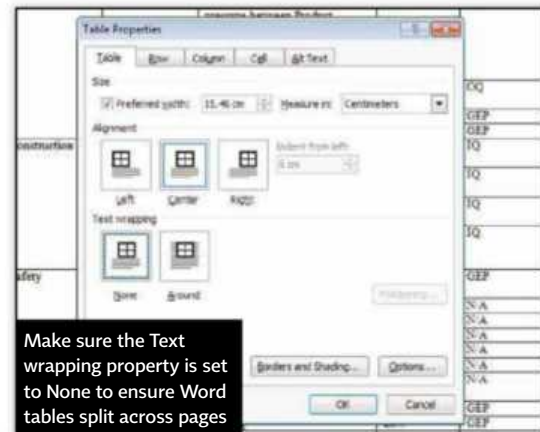
**A** Word tables seem to have acquired mysterious problems, particularly in Word 2013, and especially those that were originally created in an earlier version of Word. If you have a table that splits across pages, the simplest thing to try is Word's Format Painter. Copy the format from the table that will split, and paste the format on to your non-splitting table. That usually solves

all problems. If you don't have a table to copy, you'll need to work through the following list of properties and try changing them until you find what's causing the problem.

First of all, make sure you've set the Paragraph property for Line and Page Breaks to have both 'Keep with next' and 'Keep lines together' selected. Next – and this is the most common reason the problem occurs – select the table, and in Table Properties, on the Table tab of the dialog, make sure the Text wrapping property is set to None.

Header rows are the next thing to check. Some tables that were originally created in earlier versions of Word had the 'Repeat as header row' property set to be true for all the rows. This should only be selected for the actual header row, so make sure it's unselected for all the other rows.

One final property to check is Specify height in the Row tab of the Table Properties



dialog. If an actual height is specified that means the row is too tall to fit on the page, there's no way your table will split, so make sure this option isn't ticked.

## Can I set a two-day reminder in Outlook?

**Q** Is there a way to set all my calendar events in Outlook so I get a two-day reminder before they happen, in addition to the main reminder? If there isn't a way to have a default two-day reminder, is there a way to select all the events and set such a reminder? I'm using Outlook 2010.

Sean Finn

**A** There are two aspects to this problem; the main one is that you can't have multiple reminders in Outlook 2010. You can in Office 365, but desktop versions of Office are pretty poor in this respect, especially when compared to rival products such as Google Calendar, which lets you have multiple reminders. Outlook expects you to have one reminder, then use Snooze to repeat the reminder. This relies on you noticing the original reminder, of course.

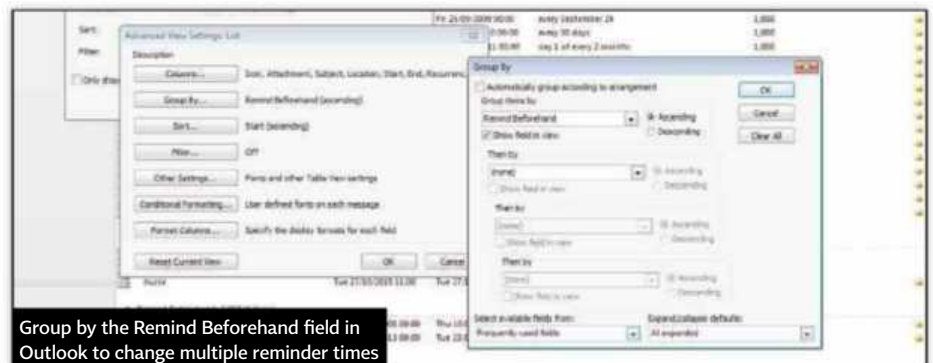
If you want to change the reminder time on all your appointments, you need to set the view for the appointments to be one that has the Remind Beforehand field showing. If you don't have this visible, you can add it – it's not among the frequently used fields,

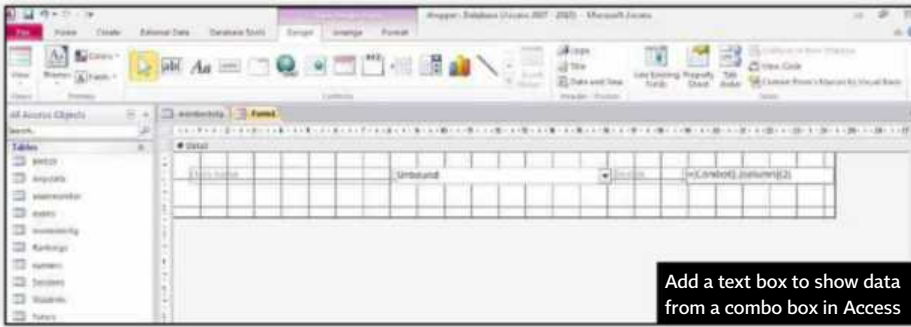
so you'll have to look in the Appointment fields group. Then group by that field; you'll need to change the fields for grouping from frequently used fields to Appointment fields again before you can see it.

Now just drag all the items to the group that has the reminder time length you want to use. If you want a two-day reminder, that will be 2,880 minutes. You can select multiple calendar items at once by selecting the first one with the mouse, then holding down Ctrl while you click on the last one.

Alternatively, you can move everything in a group by dragging the Group header to the group you want to move it to.

What this doesn't achieve is giving you multiple reminders for a single event. You might be able to sync your Android or iPhone with Outlook. Set the original reminder in Outlook, sync with your phone, then set the subsequent reminders on your phone. Depending on which operating system your phone uses, you should find the subsequent reminders are re-synced back to Outlook.





## Pie chart, one slice at a time

## Filtering Access tables

**Q** I've created an Access database for managing the membership of our sports club. It's great as it lets my colleagues and I find people who are on different teams or who attend different sports tutor classes.

One of the forms I've created shows the details for a particular member of the club. It's based on a membership table, which has a primary key that's MemberID. We can select the member's name using a combo box. What I've been asked to do is to change the combo box so that the person using the form can see the names ordered first on the class (gymnastics or Zumba, for example), then within those classes by the member's name.

My problem is that while I can get this working so the selection works, the combo box only shows the tutor group. Is there a

way in Access to be able to select on one order in a combo box, then have the form display a different field?

Janet Nixon

**A** The first thing to do is to change the query used for the RowSource of the combo box so that it shows a concatenated version of both columns. In your query, you'd have SQL code along the lines of, 'SELECT MemberID, ClassName & " - " & MemberName FROM MembersList'.

The other possibility would be to add a text box next to the Combo box to show the member's name, pulling the name from the combo box. Because numbering starts at 0 in combo boxes, if the member's name is in the third column, you'd use an expression such as '=combo1.Column(2)' for your text box.

**Q** I want to jazz up a PowerPoint presentation that I use as part of a lecture I give. To add a bit of suspense to one slide, I want to change my pie chart so that the slices appear one at a time when I click to show the next one. What's the technique for this? I'm using PowerPoint 2010.

Martin Johns

**A** To do this, begin with a chart on your slide that's an Exploded Pie. Select the chart, then from the Animations tab choose the type of animation you'd like to use – perhaps a Float in or a Wipe. Once you've selected the animation type, you should be able to choose an Effect option. The tool for this is just to the right of the Animations section of the Animations tab of the Office ribbon. If you click on the Effect options button, you should have a Sequence choice of 'By category'. This will have the effect you're looking for.

## How can I check data entry in Excel?

**Q** I have an Excel spreadsheet that has a lot of formulae that calculate results based on other cells within the sheet. Several people can enter the daily values. My problem is that they're not very careful what they enter and they then ring up and complain when the spreadsheet shows errors on the results page. This happens because they've entered a value in the wrong place, entered a text value (or the wrong text value), or deleted a value and left it blank.

I've tried setting checks within the formulae using the ISBLANK formula, but mistakes still creep through. Do I need to move to Access, or should I be thinking in terms of a user entry form where I can use a macro to check what they're entering?

Hardeep Singh

**A** You could go for either of those choices, but another option would be to use Excel's Data Validation feature. This is designed to limit what can be entered into particular cells, and it also has an input prompt so that when your users are on a particular cell, you can tell them what sort of data they should be entering.

To do this, select the range of cells that should contain values in a particular range. Then from the Data menu, choose Data Validation from the Data Tools section of the

Data tab of the Office ribbon. On the Settings tab, you can specify various options, including whole numbers, date, time, and decimal values. Two that might be useful in your case are List and Custom. The list option lets you type in a list of valid entries that will appear as a drop-down list from which the user can choose. You can either type the list of valid entries in the Source box on the Settings tab, or you can refer to a list of values elsewhere on the worksheet using a range reference such as '=K2:K10'.

You can set validation limits so the user can only enter numbers in a specified range of values, and you can do the same thing with dates and times. For example, you could set a date range that says an entry in a cell has to be within four days of today's date.

Another option that might be useful is that of validating data based on formulae or values in other cells. So you could have a check that says the value entered shouldn't be greater than a particular cell, say.

You can set up two messages for each validation formula: first, you can enter a hint that appears when the user selects the cell. You set this on the Input Message tab of the Data Validation dialog, and you can set a title and a message, so if the cell was one where the users could enter their expenses, you could have 'Daily Expenses' as the title, and

'Please enter a value between £0.01 and £25.00' as the Input Message. The exact details obviously depend on what you're checking for.

The other setting is the Error Alert. Here, you enter a title and an error message, so you might have 'Invalid expenses amount' as the title, and 'You've entered an invalid amount. Please re-enter a value between £0.01 and £25.00' as the error message.

Having used validation messages in a number of spreadsheets, we find the input message is very useful; it means people don't have to try to remember or work out what goes in a particular cell, and that cuts down the number of calls for help. ☑



Use input messages in Excel to give users hints on what data to enter

# Helpfile

Whatever your general PC, hardware and software woes, **Simon Handby** is here to help. Send your problems to [help@computershopper.co.uk](mailto:help@computershopper.co.uk)



## Where's Safe Mode when you need it?

**Q** One of my hobbies is fixing people's computers. One problem I have often faced has been a failure for a computer to boot up. Originally, fixing it would often be a case of hitting F8 on boot, selecting Safe Mode and applying a fix to whatever the issue was.

Since Windows 8, however, the F8 menu has disappeared, so we have the absurd situation where a computer that won't boot up must be booted up, and then told to boot into Safe Mode when it is rebooted! I have no idea why the simple F8 option has been removed. Can you tell me how Safe Mode

can be accessed in Windows 8, 8.1 and 10 when the computer won't boot up?

*David Clowes, 2011lancs@gmail.com*

**A** Microsoft has said that the F8 menu became impractical as the arrival of UEFI BIOS and SSDs dramatically improved boot times, but be that as it may, it still seems to be deprecating Safe Mode. It was previously possible to activate it by booting from installation media or a recovery USB drive and navigating to the troubleshooting options, but the Startup Settings tile now appears to have been

removed from here in both Windows 8.1 and Windows 10. Unfortunately, and unbelievably, that means you can't get into Safe Mode on a Windows 8 or Windows 10 PC that won't boot normally. Unless, that is, you plan ahead and add Safe Mode to the boot options while the system is still healthy.

From Windows, open the Start menu, type cmd, right-click Command Prompt in the results and select Run as administrator. In the prompt, type `bcdedit /copy {current} /d "Windows 10 Safe Mode"` and hit Enter, then type `exit` and hit Enter to close the prompt. Now open the Start menu, type `msconfig` and run System Configuration in the results. Click the Boot tab, select Windows 10 Safe Mode, tick 'Safe boot' and 'Minimal' under Boot options, enter a suitable time for you to make a choice at boot time, tick Make all boot settings permanent, then click OK. Despite the rather scary warning, you will be able to delete the Safe Mode option in the future by returning to the System Configuration applet, highlighting and deleting it.

When you reboot you should see a choice of a normal and Safe Mode boot. If you also want options for Safe Mode with Command Prompt or Safe Mode with Networking, repeat the above steps, entering an appropriate name in quotes when you use `bcdedit` in the Command Prompt, and selecting either 'Alternate shell' or 'Network' rather than 'Minimal' in the System Configuration applet.



## Please stop checking my disks

**Q** I've got a desktop PC with several hard disks. One is dedicated to the main operating system, Windows 7, while another is dedicated to Windows 10, and another to Linux Mint. The UEFI BIOS is set up so that it boots into Windows 7: when I wish to boot into either of the others I can simply use the boot override facility. The objective is to keep distinct, clean installations of each operating system.

After using Linux and restarting, the system boots back to Windows 7 normally. If I've been running Windows 10 before rebooting into Windows 7, though, the system insists on running a long-winded Check Disk, on all four of my 2TB disks! Can you suggest a fix?

*Tony Berrington, tonberr@ntlworld.com*

**A** This is probably being caused by the hybrid boot feature introduced in Windows 8, which doesn't fully shut down Windows in the same way as before; in effect, it shuts down the programs you have running, but then it hibernates the kernel rather than terminating it. This lets Windows restart more quickly, but means the system disks aren't flagged as having been shut down cleanly. When you subsequently run Windows 7, it assumes the power has been interrupted and wants to check the disks' integrity.

To fix the problem, boot into Windows 10, open the Start menu, type 'power options' and run Power Options. Click 'Choose what the power buttons do', click 'Change settings that are currently unavailable', untick Turn on fast startup and save changes. You should now find Windows 10 shuts down fully and Windows 7 no longer runs the disk checks. Note, however, that Windows 10 will be slightly slower to boot.

Fast startup is a boon in Windows 8 or 10, unless you're dual-booting with an older Windows version



Unfortunately, this PC is unable to run Windows 10.

We're sorry to let you know that this PC can't upgrade to Windows 10 because one or more things are incompatible. See right for details.

Click below to learn more about new Windows 10 devices.



Compatibility issue:

VMware SVGA 3D (Microsoft Corporation - WDDM)  
The display manufacturer hasn't made your display compatible with Windows 10. Check with the manufacturer for support.

Go home, Get Windows 10: you're drunk

## Computer says no

**Q** I want to upgrade my Windows 7 32-bit computer to Windows 10. The Get Windows 10 (GWX) application is saying that my CPU is not supported – but it is! I've tried everything with no luck.

My CPU is an Intel Lynnfield i5-760 Socket 1156 LGA. I've updated my computer's BIOS, and checked that Execute Disable Bit and Intel Virtualisation Technology are enabled. I ran CPU-Z, which reports that my CPU supports VTx, MMX, EM64T, SSE, SSE2, SSE3, SSE4.1, SSE4.2 and SSSE3. Why is GWX saying my CPU is not compatible?

Roy Davies, roycymraeg@gmail.com

**A** Your processor should be compatible with Windows 10, but it sounds like you've fallen victim to a bug in the earlier version of GWX, which sometimes erroneously reports an incompatibility. The easiest solution is simply to skip GWX and manually download and install the update. It's a good idea to take a full system backup first if you don't already have one, then visit [tinyurl.com/333download](http://tinyurl.com/333download), download the 32-bit version of the Media Creation Tool and use it to update the PC. You can find more complete instructions on page 134 of *Computer Shopper* issue 333.

## Game over?

**Q** I've got a library of old PC games which I still like to play from time to time. I've had to fiddle around a bit with compatibility settings and patches, but generally quite a few of them still work on my Windows 7 desktop PC – or at least they did. Suddenly a few games won't run: when I try to start them I get the message "Please login with administrator privileges and try again". I don't think I've installed any new software or hardware that would explain it.

Chris Burgess

**A** It sounds as though you're talking about games that came on CDs or DVDs protected by Macrovision's SafeDisc. Microsoft has long had security concerns about secdrv.sys, the driver at the heart of the copy-protection software. For Windows 10 it decided to block it altogether,

and in a recent security update (KB3086255) it also disabled the driver in Windows Vista, 7 and 8. It's likely that your PC installed the update in September when it was released.

The good news is that, for now, it's easy to re-enable the driver manually. Open the Start menu and type cmd, right-click cmd.exe in the results and select Run as administrator. From the prompt, type 'sc config secdrv start=demand' (without the quotes), press Enter, then type exit and press Enter. Before you run an affected game, re-open the command prompt as administrator and type 'sc start secdrv'. When you've finished gaming, turn the service off again with 'sc stop secdrv'.

If that sounds like too much trouble, use 'sc config secdrv start= auto' in the first step above to switch the driver on permanently, but be aware that this opens up the potential security weakness Microsoft is worried about.

## Listening in

**Q** The recording of phone conversations is almost ubiquitous in companies. You can even get a free app for your smartphone to do this transparently. I would like to add some sort of recording system to my home landline without spending a fortune on new hardware. I'd prefer one that attaches to the main phone's RJ11 lead rather than the handset lead on an individual phone, and which will pick up all telephones in the house. What would you suggest?

Richard Grant, richard@richardgrant.org

**A** It's easy to pick up a cheap adaptor for this purpose; you should find several if you search Google for 'RJ11 to



◀ It's legal to record your own phone conversations, provided you don't share them with a third party

3.5mm'. We haven't tested any, so we're unable to recommend a specific one, but look for two RJ11 ports (giving a pass-through connection) and a single 3.5mm audio output.

You may also need an RJ11 lead to run from the wall socket to the adaptor and a 3.5mm audio lead to run from the adaptor to the recorder device. You'll need a suitable recorder such as an MP3 player, or a computer running software such as Audacity. We're not sure whether a single adaptor and recorder would cover all the phone extensions in the house, but our guess is that it would.

## Cool your boots

**Q** At the launch of Windows 8 many suggested that the doubtful could try it out by creating a dual boot system, offering the choice of Windows 8 and an existing operating system. I bought a new hard drive, installed Windows 8 on it and had a menu offering me the choice of Windows 8 or Windows 7. I later updated to Windows 8.1 and liked it, and have since updated to the even better Windows 10.

Now I would just like to boot into Windows 10 and use the drive that has Windows 7 on it as a backup destination. Is this possible without a complete reinstallation of Windows 10? Also, I noticed after my Windows 10 upgrade that a new 450MB partition appeared on the relevant drive. Why is this?

John Williams, jaw71@outlook.com

**A** Assuming you're seeing a Windows 10 boot menu, with a blue background and a tile each for Windows 10 and Windows 7, it's easy to remove the Windows 7 option so that the PC always boots into Windows 10. From within Windows 10, open the Start menu, type 'msconfig' (without the quotes) and run the System Configuration app. Click the boot tab and check that Windows 10 is marked as the Default OS. If not, select it, and click the Set as default button.

Now select Windows 7, click Delete and click OK (note that this won't delete the Windows 7 disk's contents, just remove it from the list of available operating systems at boot). Finally, tick the 'Make all boot settings permanent' box. When you reboot you should find that the PC automatically enters Windows 10, and that Windows 7 is no longer available.

Regarding the 450MB partition, this is created by Windows 10 to house the Windows Recovery Environment, the simplified version of Windows that allows you to run utilities such as System Restore or Automatic Repair if you're having problems with the Windows installation. ☑

Choose an operating system



Use the System Configuration app to remove unwanted options from Windows' boot menu

# Sound-controlled fairy lights

Ever wondered how those sound-synchronised Christmas lighting displays work? Fancy having a set yourself? **Clive Webster** shows you how



**MAKING YOUR TREE** lights dance and flash to the rhythm of Bing Crosby or Wham! is surely what Christmas is all about. While you can buy audio-lighting control boxes off the shelf, they're often hard to find, expensive and limited. Make your own, from a Raspberry Pi and a relay board, and you can scale your project as you see fit and customise it easily.

At the heart of this project is an ingenious piece of software called LightShow Pi ([lightshowpi.org](http://lightshowpi.org)), which will run on any Raspberry Pi board; we used a B+, but you could use the smaller A+ or older models (a Pi 2 is overkill). LightShow Pi analyses music in real time, outputting signals according to spikes within frequency bands. This means there's no need to listen to Fairytale of New York 20 times to program the beats and transitions: LightShow Pi does it for you.

## GONE SHOPPING

Whichever Pi you use, the General Purpose Input/Output (GPIO) pins can't provide enough power for a string of fairy lights, so you'll need some way of controlling an external power source. We've chosen a relay array for our project, with each relay acting as a switch governed by the Pi's GPIO signal. You could use amplifying transistors as 'digital switches', but these would be very specific to the project and not as flexible. For example, if you bought a 240V AC relay board you could control mains-powered lights from your Pi – hook up some outdoor speakers and you're ready to really annoy the neighbours. You should only ever use the AC mains current if you know what you're doing.

Light up the neighbourhood this Christmas with fairy lights that flash with the beat



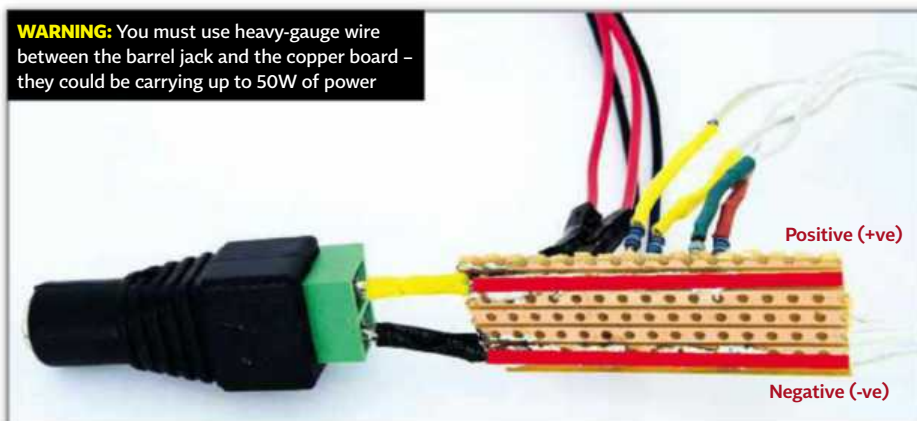
We chose a four-way, 5V relay board, although eight- and 16-way boards are available, as are single relay units. We bought four sets of battery-powered, static, LED fairy lights knowing that they would operate at near-enough 5V, be easy to work with and wouldn't mind being switched on and off rapidly. Don't use filament-type lights, as these tend to blow when turned on and off frequently, and make sure you use static rather than multifunction lights.

As none of the lights we'd bought used 5V natively (the white and pink used 4.5V while the green set used 3V), we needed to measure the voltage and amperage of each set to determine what kind of resistor to use. We applied Kirchhoff's Voltage Law and Ohm's Law to arrive at 130Ω for each white and pink set, and 100Ω for the green set.

We can now build the power unit. As the main connection between the power brick and the lighting unit might take up to 50W of power, we took two lengths of cable from a spare Molex connector. Screw one end of the yellow cable into the positive terminal of the 1.2mm female barrel jack, and one end of the black into the negative. Then solder the other ends into your copper board, making a positive strip of holes (yellow) and a negative (black). Next solder the other end of the four resistors into the yellow strip and solder some wire to the other end of each resistor. Finally, solder two male-to-female jumper wires to the 'yellow' strip, and two male-to-female jumpers to the 'black' strip. Only the cables connecting the barrel jack need to be heavy-duty, as the others will only carry up to 1.5A (7.5W).

To slave the LED lights to the Pi-controlled relay, just chop the battery packs off. If you

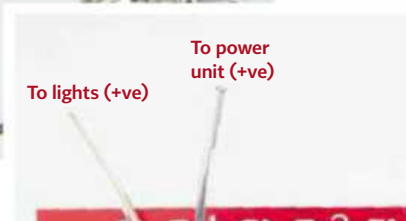
**WARNING:** You must use heavy-gauge wire between the barrel jack and the copper board – they could be carrying up to 50W of power



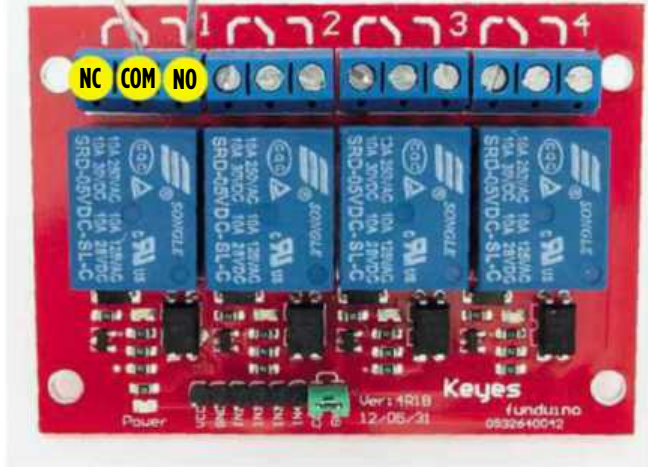




An easy way to know which wire of the LED lights is positive is to look for the resistor, which will always be on the positive wire



Slave your LED lights to the relay like this. 'NO' stands for 'Normally Off', shown by the unconnected marking



can tell which wire is negative and positive at this point, mark up the wires. If not, touch one wire to a 5V pin on the Pi and the other to a Ground pin (while the Pi is on); if they don't light you've got them the wrong way round, but won't have harmed the Pi or the lights. Screw the wire with the resistor into the NO junction and the LED string's positive wire into the COM (see picture, right). Solder the negative wire of the LED string into the negative strip of the power unit.

While 5V lets us power everything from one supply without step-up or step-down transformers, we do have an amperage problem. The Pi probably needs 1.5A, as does the relay board, while the lights each need around 20mA; we might have got away with a 6A supply but these cost roughly the same as the 10A supply we chose, and extra headroom is always useful. Mount your electronics on some hardboard, or something equally robust, in a case that won't melt or get too hot.

### SOUND DECISIONS

Although LightShow Pi is set up to play music from the Pi's SD card, you would have to remove all the spaces and special characters

from your music tracks' filenames, as Linux doesn't like those. It would also take all day to load the music on to the Pi over a network. Thankfully, LightShow Pi offers a feed-in option, so we can use a mini-jack splitter to feed both our speakers and the Pi simultaneously. This method requires a USB sound card (such as the £4 one at [tinyurl.com/piusbaudiocard](http://tinyurl.com/piusbaudiocard)) as the Pi has no native audio-in jack, although the on-board audio of the Pi is so awful we'd use a USB sound card even if we were playing music from it directly.

Install Raspbian on your Pi (see [www.raspberrypi.org/help/noobs-setup](http://www.raspberrypi.org/help/noobs-setup)) and immediately uninstall Wolfram: it's too large and can interfere with projects. Then update Raspbian and its applications, before installing LightShow Pi:

```
sudo apt-get remove
-y wolfram-engine
sudo apt-get update
sudo apt-get -y
upgrade
git clone https://
togiles@bitbucket.
org/togiles/
lightshowpi.git
cd lightshowpi
git fetch && git
checkout stable
sudo ./install.sh
```

The last command will take ages to complete. Once it's done, ignore the suggestion to reboot and



Use the 'gpio readall' command to discover which pins to use

## SHOPPING LIST

10x 1000hm resistors (9475567)	£0.24
<a href="http://uk.farnell.com">uk.farnell.com</a>	
10x 1300hm resistors (9342567)	£0.17
<a href="http://uk.farnell.com">uk.farnell.com</a>	
Raspberry Pi B+	£35.00
<a href="http://makersify.com">makersify.com</a>	
5V/10A Power supply	£22.00
<a href="http://makersify.com">makersify.com</a>	
Adafruit USB audio adaptor	£5.00
<a href="http://makersify.com">makersify.com</a>	
Female 1.2mm barrel jack	£2.00
<a href="http://makersify.com">makersify.com</a>	
16GB microSD card	£4.48
<a href="http://www.amazon.co.uk">www.amazon.co.uk</a>	
Mini-jack splitter	£3.94
<a href="http://www.amazon.co.uk">www.amazon.co.uk</a>	
4-way 5V relay	£9.60
<a href="http://www.hobbytronics.co.uk">www.hobbytronics.co.uk</a>	
20 female/female jumper wires	£1.44
<a href="http://www.hobbytronics.co.uk">www.hobbytronics.co.uk</a>	
20 male/female jumper wires	£1.44
<a href="http://www.hobbytronics.co.uk">www.hobbytronics.co.uk</a>	
2x 20 battery LED fairy lights (white)	£5.74
<a href="http://www.lights4fun.co.uk">www.lights4fun.co.uk</a>	
20 battery LED fairy lights (pink)	£2.99
<a href="http://www.lights4fun.co.uk">www.lights4fun.co.uk</a>	
20 battery LED fairy lights (green)	£2.99
<a href="http://www.lights4fun.co.uk">www.lights4fun.co.uk</a>	
Copper board	Free?
<a href="http://Yourbitsbox?">Yourbitsbox?</a>	
Delivery	£5.39
<b>Total</b>	<b>£102.42</b>
-----	
Excluding reusable components	£32.00

type 'gpio readall' (without the quotes) and hit Enter. This will list all the functions and names of your Pi's GPIO pins. Look for GPIO 0, 1, 2 and 3 and make a note of the physical pin to which those virtual functions are assigned. For our Pi B+ we needed to use Pins 11, 12, 13 and 15. Now shut down the Pi by typing 'sudo shutdown -h now'.

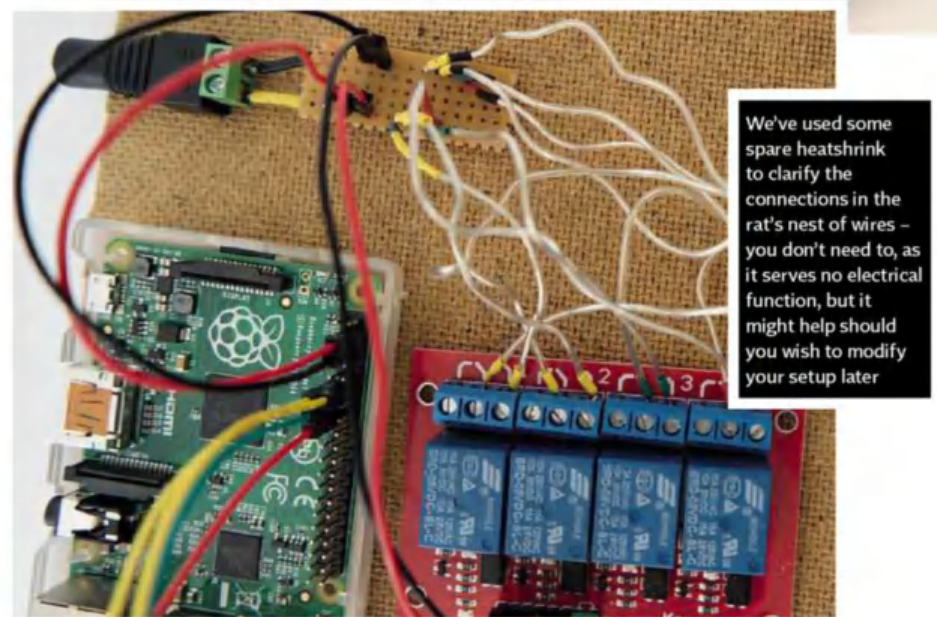
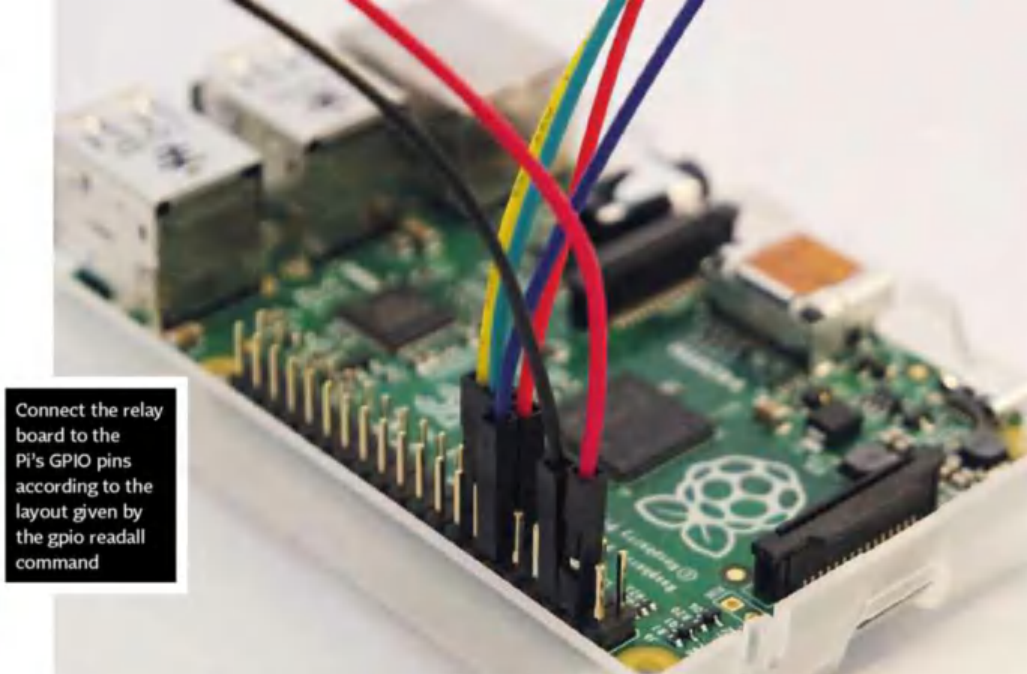
With the Pi powered down, disconnect the Micro USB power and connect the Pi to your power unit via a positive jumper in Pin 2 and a negative in Pin 6 (see diagram, page 138). Connect GPIO 0 on your Pi to IN1 of the relay and so on. Connect the last positive jumper lead from your power unit to the VCC pin of the relay board, and the negative lead to GND.

Next, insert your USB sound card and plug a set of speakers or headphones into the headphone port. This will help you test that the software and the relay are working. Also, the test tune is hilarious.

Power up the Pi and log in. Move to the LightShow Pi directory by typing 'cd lightshowpi', then 'sudo python py/hardware\_controller.py --state=flash' (both without the quotes). You should see the screen list each relay channel and see the LED next to each relay unit flash twice (and hear the click of the relay). Check that Channel 0 on the screen

Pi Model B/B+			
3V3 Power	1	2	5V Power
GPIO2 SDA1 I2C	3	4	5V Power
GPIO3 SCL1 I2C	5	6	Ground
GPIO4	7	8	GPIO14 UART0_TXD
Ground	9	10	GPIO15 UART0_RXD
GPIO17	11	12	GPIO18 PCM_CLK
GPIO27	13	14	Ground
GPIO22	15	16	GPIO23
3V3 Power	17	18	GPIO24
GPIO10 SPI0_MOSI	19	20	Ground
GPIO9 SPI0_MISO	21	22	GPIO25
GPIO11 SPI0_SCLK	23	24	GPIO8 SPI0_CE0_N
Ground	25	26	GPIO7 SPI0_CE1_N
ID_SD I2C ID EEPROM	27	28	ID_SC I2C ID EEPROM
GPIO5	29	30	Ground
GPIO6	31	32	GPIO12
GPIO13	33	34	Ground
GPIO19	35	36	GPIO16
GPIO26	37	38	GPIO20
Ground	39	40	GPIO21

Pin 1 is nearest the microSD card slot, with Pin 2 opposite



corresponds to relay 1 and so on. Press Ctrl-C to stop this test. Now you can test whether the relays switch on and off in time to music. Type 'sudo python py/synchronized\_lights.py --file=/home/pi/lightshowpi/music/sample/ovenrake\_deck-the-halls.mp3' (without quotes) and bask in your (hopeful) success.

### HAPPY HOLIDAY

By default, LightShow Pi is set to run on an array of eight relays, analysing for eight frequency bands. To tell LightShow Pi we only have four relays, create a new config file 'sudo nano ~/.lights.cfg' (without the quotes) and enter:

```
[lightshow]
mode = audio-in
```

```
gpio_pins = 0,1,2,3
custom_channel_mapping - 1,1,3,4
```

The 'gpio\_pins' variable tells LightShow Pi which pins you're using, and as we've listed only four it knows to split the work four ways rather than eight. The 'custom\_channel\_mapping' variable is slightly odd in that each comma-separated place is mapped to a GPIO pin; by specifying '1,1,3,4' we've given bass frequencies to channels 1 and 2 (our white lights), skipped the lower mid-range, given the upper mid-range to channel 3 (green) and sent spikes of high-frequency to our shocking pink lights. We just think this looks nice - have a play with your setup to see what looks good to you. Save and exit this file (ctrl-x, y, Enter).

To ensure the USB sound card is used, edit the ALSA sound driver by typing 'sudo nano /etc/modprobe.d/alsa-base.conf' (without the quotes) and insert a hash (#) before the line 'options snd-usb-audio index=-2'. This 'comments out' the command that would otherwise de-prioritise the USB sound card in the list of available audio hardware. Save and close as before.

The last job is to set LightShow Pi to run on startup. Type 'sudo crontab -e' (without the quotes) and add the following two lines at the bottom:

```
SYNCHRONIZED_LIGHTS_HOME=/home/pi/lightshowpi
@reboot $SYNCHRONIZED_LIGHTS_HOME/bin/start_music_and_lights
```

It's strange to declare a variable in the Cron like this, but LightShow Pi won't start unless you do. Pay particular attention to the spelling. Save and exit (as before) and your system should be ready to go. You can either reboot the Pi (sudo reboot) or start LightShow Pi with the command 'start\_music\_and\_lights'. Merry Christmas! 🎅

### NEXT MONTH

#### TURN YOUR NAS INTO A TV-RECORDING VIDEO STREAMER

Get the best out of your TV by recording shows on your NAS and streaming them around the home

# Improving your video soundtracks

From capturing dialogue on location to adding narration and music, **Ben Pitt** reveals the best ways to liven up your video project's soundtrack



**SOUND IS A** critical part of video production. We'd argue that it's even more important than the video. After all, recorded sound without accompanying pictures is common, but moving pictures without sound are virtually non-existent.

The soundtrack can be more complex than the picture, too. Most of the time the picture comprises a rectangular view of a single scene. The soundtrack may contain dialogue, background noises on location, music, sound effects and narration. All these elements need to slot together into a seamless whole.

Sound is also harder to control than light. If you point a camera's lens in a particular direction it captures the view in that direction. Sound, on the other hand, goes round corners, passes through walls, bounces around and often takes a while to stop reverberating.

It's easy to concentrate on the picture and completely forget about sound when shooting, especially as most cameras lack a headphone socket. However, give the soundtrack the attention it deserves and the benefits can be dramatic.

We've covered some of these techniques in previous *Multimedia Expert* articles. If you have a back catalogue of magazines, dig out issue 294 for our guide to off-camera sound-recording equipment, issue 316 for working with incidental music, issue 326 for microphone techniques and issue 332 for recording your own sound effects. But if you only read one *Multimedia Expert* article about video soundtracks, make it this one.

## RECORDING ON LOCATION

There's a basic problem with making videos of people talking: the best place for the lens is different to the best place for the microphone. You might position the camera on the other side of the room, perhaps three or four metres away, and zoom in to get the shot you want, but the ability to point a microphone in a specific direction is much more limited.

If you want to record more of the sound you want – such as dialogue – and less of everything else, the best way to do this is to position the microphone close to the sound source. The closer you are, the louder the direct sound, so you can afford to turn down the microphone to reduce the amount of background noise and reverberation. Physically separating the microphone from



Spending time on your video soundtracks will make them appear much more polished

the camera also eliminates whirs from the lens, general handling noise and your own breathing – a common problem when the camera is held just in front of your face.

Using an external microphone brings its own complications, though. Few digital cameras include a microphone input and even fewer have a headphone output, level meters and a manual volume control to let you

**Sound is much harder to control than light. It goes round corners, passes through walls and bounces around**

monitor and control the recording. Many external microphones are battery powered, so at the very least you need to be able to make sure it hasn't run out of juice.

A manual volume control is useful to maintain an even volume throughout the recording. Automatic microphone gain means the volume rises and falls automatically depending on how loud the input is, but the downside is that it turns up unwanted

background noise in the gaps when no-one is speaking. You'll generally get better results by setting the volume manually. Just be careful not to overload the input.

If your camera has a microphone input, a lapel microphone, sometimes known as a lavalier microphone, can work well to capture one person speaking. The Audio Technica ATR3350 costs around £20 and has a minijack

output ready to plug into a camera. If you're used to the camera's on-board microphone, we suspect you'll be amazed at the difference this cheap microphone will make, simply because it can be positioned nearer to the subject. Pricier,

higher-quality microphones are available, but most have XLR outputs, which won't connect to minijack microphone inputs.

If your camera doesn't have the necessary sockets or you want to record more than one person, it's best to use a standalone recorder. Standalone recorder quality tends to be higher than recording directly to a camera. The ability to record 24-bit audio means you can set the level fairly low to ensure that

peaks aren't distorted, but still record with plenty of bits to maintain high-quality sound.

Using a standalone recorder means you'll need to be careful to press record and stop on both video and audio devices. You'll also need to sync them up later in your editing software. A hand clap or other clear cue at the start of recordings makes this fairly easy.

A standalone recorder is probably more trouble than it's worth for casual family videos, but well worth the effort for wedding speeches, business presentations and dramatic productions. They're available from the likes of Tascam, Olympus, Zoom and Yamaha, with prices starting at £65. Some recorders also include XLR inputs so you can connect professional microphones, but their integrated stereo microphones are usually more than adequate. If you want to record outdoors, look for a model that includes a foam wind shield to cover the microphones.

Wind is a big problem for cameras' integrated microphones, and digital wind noise suppressors are no match for a proper foam wind shield.

Regardless of which type of microphone you use, it's worth capturing a few sound-only recordings. It's often useful to edit the video and audio separately, and having a stock of sound recordings to draw on can get you out of a tight spot later. Thirty seconds of background ambience can be used to fill in any gaps, perhaps where the soundtrack for a video clip is spoiled by a random background noise. If there's music playing where you're shooting – perhaps at a wedding reception or a festival – it's useful to have a continuous recording of one or two minutes to use as background music behind a montage of other clips.

**EDITING TECHNIQUES**

Most editing jobs start with footage, and the sound is tackled later. There are exceptions, such as pop videos or if you're cutting a montage of clips to music, but as a rule it's best to get the video into shape first.

When you're ready to concentrate on the audio, one of the most useful editing techniques is to break the link between a video clip and its audio soundtrack. This is usually

➔ The £65 Tascam DR-05 V2 captures high-quality stereo audio



available as a right-click command and called Unlink, Break Apart or something similar. From then on you'll need to be careful to move audio and video together if you want to maintain lip sync. The upside is that you're free to edit the tracks independently.

One simple trick is to mute or delete the audio component entirely if it's spoiled by background noise or wind noise, and replace it with another audio recording. This is where the clips you shot especially for sound can come in useful. Failing that, have a sift through your footage to find a clip with a suitable soundtrack, unlink and delete the video and use its soundtrack on a dedicated track on the timeline.

Overlapping and crossfading audio clips is useful to avoid abrupt changes. This technique is often used for videos too, and in most editors adding a video transition also applies a crossfade to audio clips. However, a simple cut often works best for video, while you might want a crossfade for the soundtrack.

Another common editing technique is B-roll cutaway shots. This refers to videos shoots where two cameras are used – A and B. Camera A captures the main footage, perhaps of someone being interviewed. Camera B is for the interviewer. Normally the edited video shows whoever

is talking, but sometimes the video cuts to the interviewer for a reaction shot. Here, the B-roll shot is often used to mask an edit in the A-roll footage, such as to remove a cough or a long pause. Whereas just chopping a section out of the A-roll footage would result in a disjointed appearance, it's much easier to join the two soundtracks together seamlessly. Inserting a B-roll cutaway joins over the gap in the video. You probably don't need the sound for the B-roll clip, so mute (or unlink and delete) its soundtrack element.

An L cut is where the audio and video edit points are a few frames out from each other. It's sometimes done for practical reasons, such as to avoid cutting off dialogue mid-sentence. At other times it's used for artistic reasons. Introducing the background sounds from a new scene a few frames before the video can help to transport the viewer smoothly from one scene to another. Similarly, you might start with a disembodied narration, then cut to the shot of the person speaking a couple of seconds later. That way, the viewer is hopefully already engaged in what the person is saying before they appear on camera.

If you need a voiceover without footage of the person speaking, it's usually easier to record it in front of your editing software. Most editors include a narration function where you simply hit record and speak as you watch the video play back. Turn down your speakers or use headphones to avoid the original soundtrack being recorded at the same time. This won't be a disaster, but a clean recording means you can shift the narration track around the timeline if necessary. USB headsets give great results, and remove many of the headaches involved in microphone connection and placement.

## SETTING THE MOOD

Music can make a huge difference to a video production. The same footage can seem uplifting, melancholic, scary or funny simply through the choice of music, and it can fall flat without any.

In the days of burning home videos to DVDs it was a simple matter of picking something from your CD collection and adding it to the timeline. It's not so easy now videos are shared online. YouTube, Vimeo, Facebook and other video-sharing services use algorithms to identify the music. When a match is found, depending on the licence between the video-hosting site and the music publisher, the video will be blocked, muted or shown with adverts overlaid across it.

The best way to avoid this is to use royalty-free music, which is produced specifically for use in productions. It's often bundled with consumer editors in the form of SmartSound tracks that are automatically adjusted to fit the length you require.

However, there's usually only a handful to choose from, so it's rare to find something that's a great fit for a production.

There's a world more choice online, however; just search for 'royalty free' in music download stores such as iTunes, Amazon and Google Play Music. Throw in some additional search terms such as 'blues', 'uplifting', 'Turkish' or 'bagpipes' and you should be able to home in on something suitable.

One handy thing about royalty-free music is that it rarely includes vocals. This helps the music sit in the background and not compete with dialogue. Licences for these libraries are usually for non-commercial use only, although these online music stores aren't always clear about what's allowed.

Audio Network ([www.audionetwork.com](http://www.audionetwork.com)) specialises in royalty-free music, its licences are clearer than those of the sites above and quality is consistently excellent. There's detailed metadata so you can search for



↑ The Audio Technica ATR3350 mic is arguably the best £20 you could spend to get superior soundtracks

specific things such as 'sinister slow cello', 'angry baby' or 'African pet party'. Compositions often include variations so you can use the main track for an introduction and then a stripped-back version – known as a musical bed – elsewhere. Business use (including monetised YouTube videos) costs £120 plus VAT, but a non-commercial licence is just under £1 a track.

Music can help to paint a scene, and so too can sound effects. Some gentle birdsong or the sound of an open fire can be extremely evocative, and they needn't be loud in the mix to have an effect. In professional productions virtually every sound you hear apart from dialogue is taken from sound libraries or recorded by a dedicated team of Foley artists (see *Multimedia Expert*, *Shopper* 332). There's no need to go to such extremes for home videos, but for dramatic productions and business videos it can bring a scene to life.

## IN THE MIX

As the soundtrack builds up with multiple simultaneous elements, you'll need to balance their levels carefully. The first step in this process is to reduce the level of each element. Camera soundtracks with automatic gain, as

well as music, tend to be recorded at full volume, so combining two or more quickly leads to distortion of the editing software's audio output. This distortion will appear in exported files, too.

Some editors such as Sony Movie Studio show an audio level meter by default, but in others you'll need to locate an audio-editing mode to access the full set of audio features. It may be enough to set the volume for each track or audio object, but at other times it can be useful to draw audio envelopes so the volume changes over time. This technique is used to reduce the volume of other sounds when there's dialogue – a technique known as audio ducking. Corel VideoStudio X8 includes the ability to apply this automatically, but it's not hard to draw in envelopes manually. It's best to avoid making the volume jump up and down too enthusiastically. Reduce the volume quickly just before dialogue, but use slower changes when bringing the volume back up again.

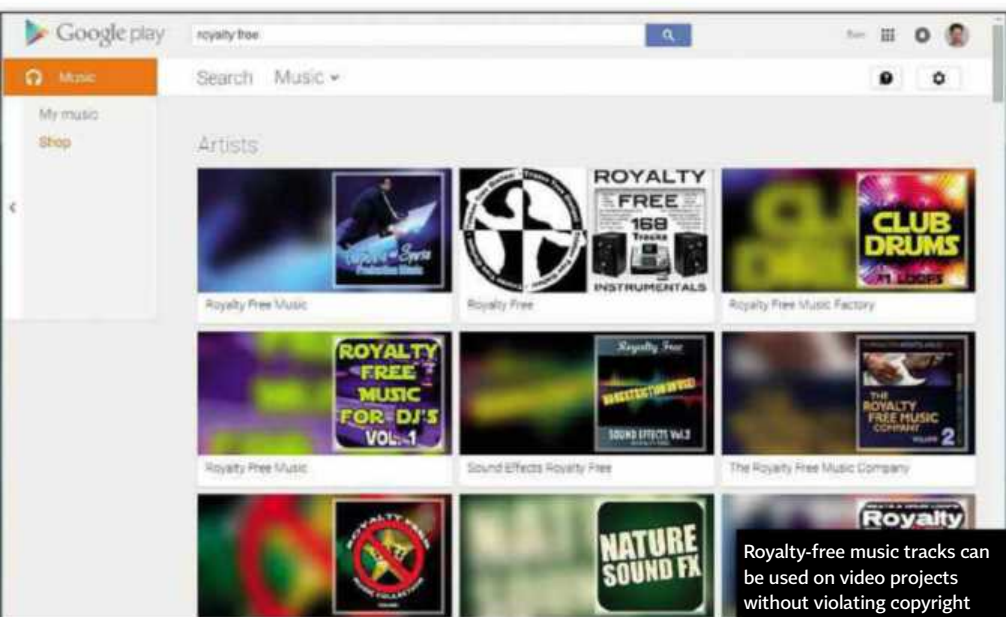
Once you've got a pleasing balance of the various audio elements, try adding a compressor effect to the master audio output, if your editor allows this. In Sony Movie Studio, you can do this by clicking the Master FX button near the top of the master level meter. Compression smoothes out changes in volume and can help the various elements to gel together. It can also help you achieve a healthy overall volume without going into distortion. The settings can be tricky to get your head around, but these effects come with presets to help you get started.

As with any creative task, video soundtracks can be as simple or as complex as you want them to be. Sometimes simplicity is best, but carefully selecting, placing and mixing elements can make a big difference. If you've spent a few hours on the video, it's worth spending at least an hour raising the soundtrack to the same standard. 🎧

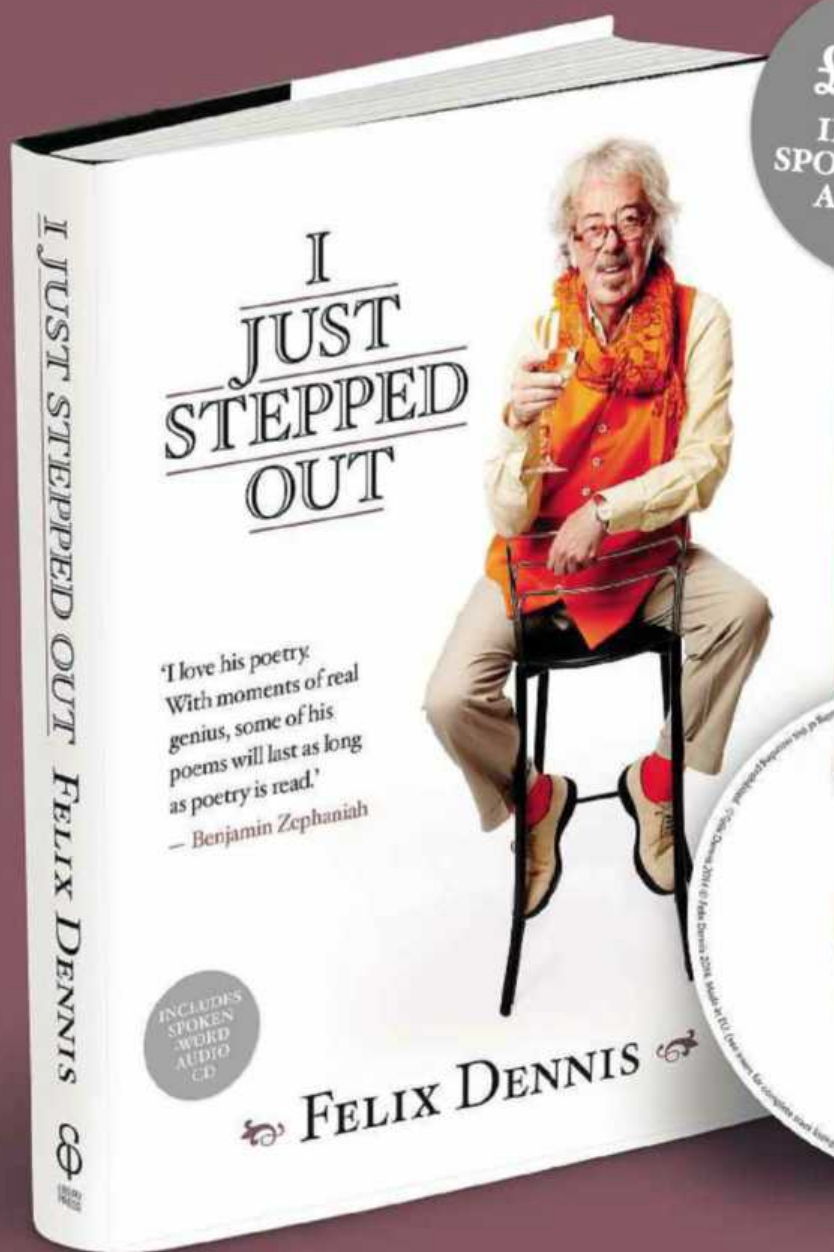
## NEXT MONTH

### WORKING WITH 4K

Is it worth shooting 4K video? We test the hardware, explore the techniques and assess the benefits



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# Interior design on your tablet

Give your home a makeover and avoid design disasters with the help of your iOS or Android device. **Ben Pitt** shows you how



**AS TECHNOLOGY JOURNALISTS**, we spend most of our lives surrounded by cardboard boxes and battery chargers, but that doesn't stop us dreaming of living a life of minimalist designer luxury. The right app can bring this one step closer to reality – or, at the very least, allow us to dream a little more vividly.

Interior design is a complex balancing act of aesthetics, practicality and bank balance, and mistakes can be costly in all three areas. That's why it's a good idea to map your ideas out before you go shopping. A scale model will help you think about how everything will fit, but creating a digital 3D model with one of the free apps we've highlighted this month will give you a deeper insight as to how everything will look when you're standing in the room.

## Roomle



Free, [www.roomle.com](http://www.roomle.com)

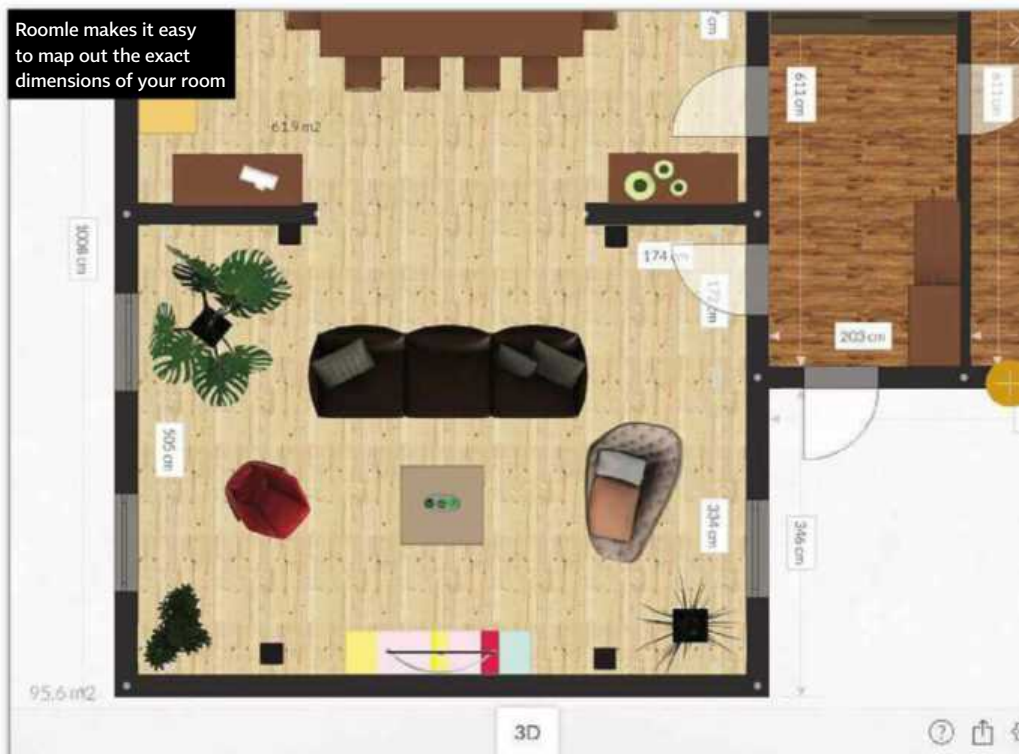
Inspiration is all well and good, but at some point you need to come up with your own ideas. Roomle is a 3D modelling app for iOS devices designed for interior design planning.

Start with a blank canvas and drag a finger to draw a wall. Dragging again will just pan the canvas, so hold for a moment before dragging to create additional walls. As you do so, measurements will be shown in centimetres. Tap the cog icon at the bottom-right to switch to feet and inches or to adjust the default height and thickness of walls.

Adjusting the size and location of existing walls is a simple matter of tapping a wall or an intersection to select it and then tapping again and dragging.

Once you have the room dimensions mapped out, it's time to populate your model with furniture, doors, windows and other objects. Tap the centre-right button and use the controls on the left to browse by category and subcategory. Most types of furniture are covered, from sofas and desks to trampolines and shoe racks, although in most cases there are just one or two options to choose from. The Brands section allows you to be a little more

Roomle makes it easy to map out the exact dimensions of your room

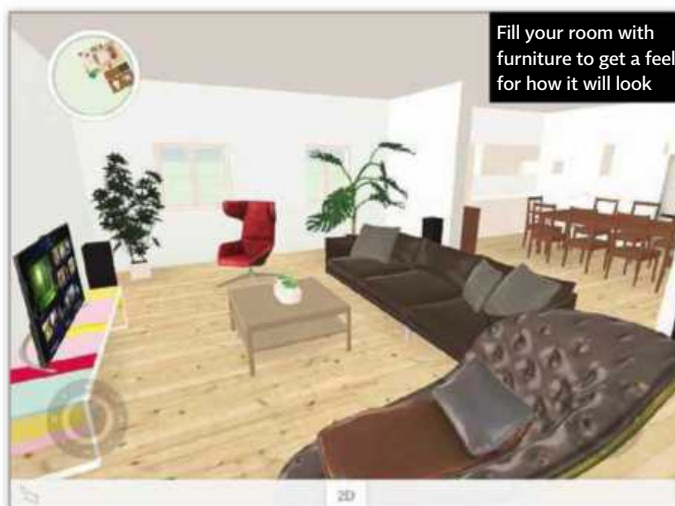


specific about the design of objects but it's currently limited to a small selection of items from eight manufacturers. As such, Roomle isn't necessarily the best app for creating grand artistic visions, but it's ideal for planning how the space will be used and getting an overall feel for the layout.

The app comes into its element if you're buying a home. Most estate agents produce scale plans, often with dimensions, which you can use when creating your walls to make sure things are to scale. Each model has a default size, but these can be adjusted by selecting the model, tapping the '?' button and

adjusting its dimensions. There are also options to set its colour, location and elevation from the ground. Measure your existing furniture, find something vaguely similar from the library and adjust the dimensions to match. This will give you an idea of how everything will fit in your new home.

If you haven't already found it, tap the 3D button at the bottom-centre to switch from a top-down 2D plan to a full 3D model. A single-finger swipe rotates the model, while a two-finger swipe moves and zooms. Tap the eye icon in the bottom-left to switch to a ground-floor view and use the onscreen controllers to walk and



Fill your room with furniture to get a feel for how it will look



pan around. You can also step outside and check what passers by will be able to see when they peer through the window.

Layouts that look well conceived as a top-down plan can seem less elegant or simply impractical when rendered in 3D, and parts of the room can look distractingly bare or overcrowded. This app acts as a useful early warning system for these potential problems.

**REALITY BITES**

Roomle also includes an Augmented Reality mode, which works in conjunction with the iOS device's camera to superimpose items of furniture and other objects across a live video feed. Motion sensors in the device mean you can pan around the room with a fair degree of accuracy. It's also possible to move and rotate the virtual object onscreen. There's a choice of showing a single selected object or all objects in the virtual room. It's not the most useful feature in the app, but it's probably the most fun.

We noticed a few quirks with Roomle, such as windows that appeared at floor height by default and doors that refused to sit where we wanted them. Overall, though, this app is polished and responsive, and the touchscreen interface provides a natural way to navigate the model. 3D models can also be accessed and edited on desktop computers via a web interface, and shared by emailing a web link.

**Houzz Interior Design Ideas**



Free, [www.houzz.co.uk](http://www.houzz.co.uk)

Every interior design project needs some artistic vision, and that's where Houzz comes in. The iOS and Android apps are little more than wrappers for the web content available at [www.houzz.co.uk](http://www.houzz.co.uk), but this catalogue of eight million interior design photos is superbly

curated and presented. You can browse by room type, design style, size, budget, wall colour, floor finish and geographic location. If you're looking for ideas for an affordable, Mediterranean-themed, L-shaped kitchen, or perhaps a rustic, masculine walk-in wardrobe, you'll find no shortage to choose from. If there's a tag on a product shown in a picture, tap it to see further information, including prices and links to online stores.

Over on the Products tab, you can browse everything from bunk beds to chopsticks and toilets to weather vanes. There are masses of unusual and genuinely interesting products, with web links to buy them online. There's also a directory of local designers and other trades, as well as articles and a forum.

Much of the content is filtered by popularity, and as a result the quality is remarkably high. This app isn't sophisticated on a technical level, but it's a must for anyone contemplating an interior design project. It's much more appealing than trawling home furnishing websites or department stores.

**Homestyler Interior Design**

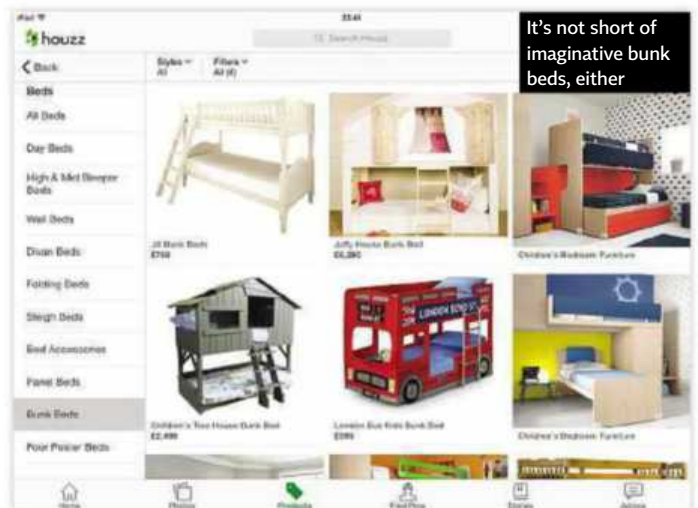
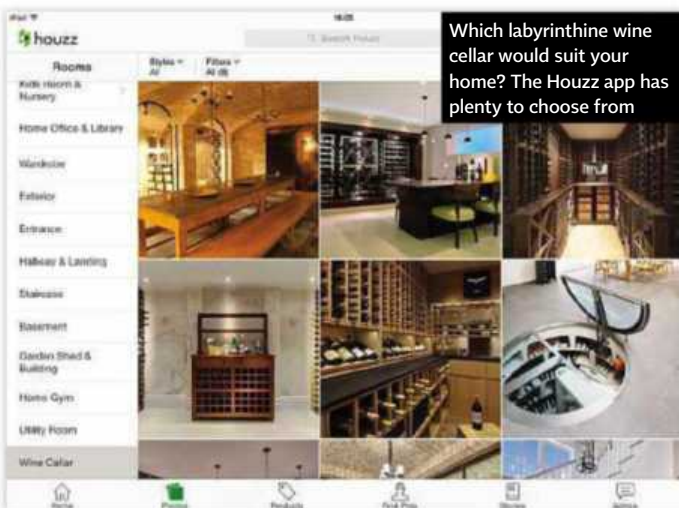


Free, [www.homestyler.com/mobile](http://www.homestyler.com/mobile)

Homestyler Interior Design is made by Autodesk, a leading name in professional 3D design and graphics software. The company has expanded enthusiastically into consumer software in recent years, and publishes dozens of apps for iOS and Android.

Homestyler overlays 3D furniture and other items on to photos of rooms. Unlike Roomle, it's not possible to rotate the 3D space or take a virtual walk around. You'll also need a photo of a relatively empty room to start with. It's harder to visualise the furniture you're thinking of buying when it's piled up on top of what you already have.

However, the app's use of photos makes it quick to create realistic images. It also has the distinct advantage of a massive library of



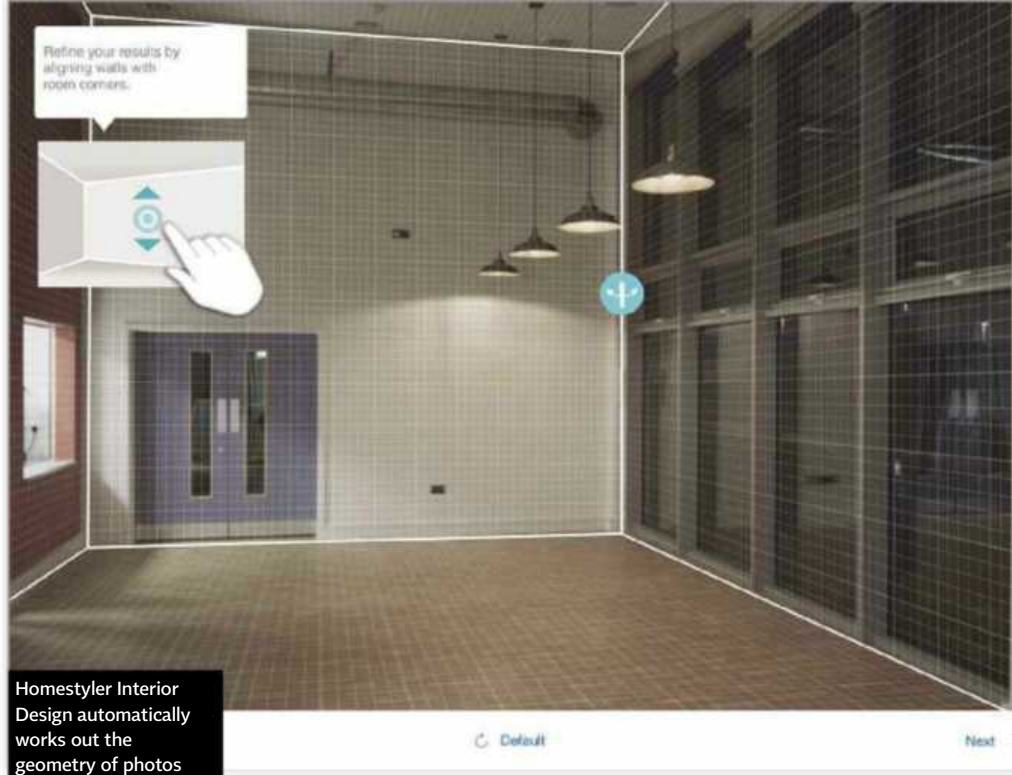


high-quality 3D models to draw on. The fact that so much product design is done using Autodesk AutoCAD software clearly helps. The 3D models themselves are extremely detailed, with photographic textures and the ability to cast shadows. The furniture designs are generally excellent too, and a big step up from the generic models offered by Roomle. Best of all, these are real products and come complete with links to the retailers' websites. Only a few are available to buy in the UK, and frustratingly there's no way to export a web link to view on another device. Still, it's not too hard to track down the same product once you've located it in the app.

### PICTURE THIS

To start, you need a picture of an empty room. There are various converted warehouses, stately homes and private jets to choose from, but it's more fun to use your own picture. You can use your iOS or Android device's built-in camera, but it might be worth taking a photo from a dedicated camera and importing it into the device before you load the app. The chances are you'll achieve higher image quality, and you'll also benefit from a wider-angle shot that shows more of the room. It's worth setting the white balance carefully to avoid colour casts, as these will be at odds with colours in the 3D models. Be careful to avoid foreground objects as the app won't be able to place models behind them.

Start with the Create New Design button and take or import a picture of your room. Tap Next and the app will look for converging lines to try to work out the perspective of the room. This tends to be more successful when both the floor and ceiling are visible, as it gives the app some box-shaped lines to work with. However, it's not hard to adjust if the wireframe mesh doesn't look right. Drag any



surface to move it back and forth, and drag the blue buttons to rotate around that axis.

The next screen invites you to enter the measurement of one of the lines in the scene. This might be the floor-to-ceiling height or whatever else you've aligned the grid to. Using the correct size will ensure that the models you import will be to scale.

### FULLY FURNISHED

Next it's time to import some furniture. Tap the Catalogue button and browse by room and furniture type. Tap Details to see more information about the product, or the thumbnail image to bring it into your room. Tap a model to select it and drag to reposition it in the room. To rotate, move one finger up and another down. Pinching and pulling with two fingers shrinks and enlarges the model,

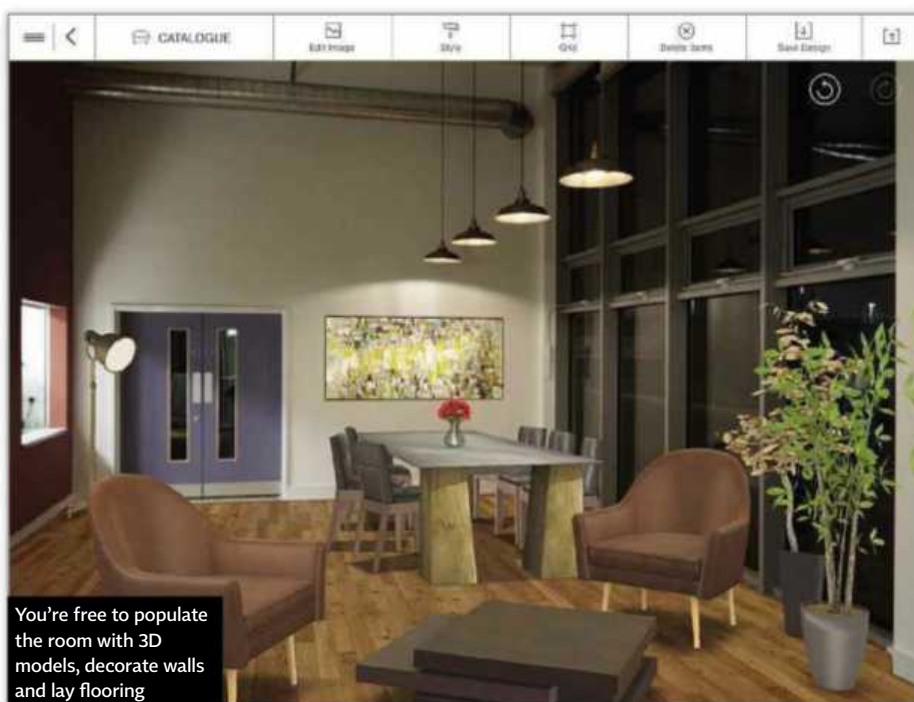
but the app will first ask if you really want to adjust the size away from the correct size of the product in question. Dragging up or down with two fingers adjusts the object's height. Be warned that doing so makes it harder to position objects convincingly. We found it easier to get the horizontal location right first and then adjust the height as necessary. Tapping Grid and enabling Snap To Grid can help you get your bearings if the geometry starts to feel disconnected.

Some models can look a little bright or dark compared to their photographic surroundings. To combat this, tap the blue button that appears when a model is selected and adjust the Brightness control. You'll also find options to restore the object to the correct scale, to duplicate it and to visit the manufacturer's website.

Homestyler also includes tools to edit the background photo. Tap Edit Image for a Brightness control and a Concealer that clones from one part of the image to another to remove small items you don't want in the image. The Style button includes controls to experiment with paint colours, wallpaper and floor finishes. This can be hit and miss, particularly in its ability to fill a surface area without leaking into other areas. There's a Remove tool to clean up areas but on the whole this is one of the weaker parts of the app. It's handy for trying out colour schemes before committing with a paint brush, but it's frustrating that the Undo button doesn't work for edits to the background image.

When you're ready to save, the app will ask for a name and description and invite you to share it with other Homestyler users. There's a chance to apply colour filters, which can be useful to pull the colours of the various elements together. Finally, the app invites you to share your efforts on Facebook, Twitter, Pinterest and via email.

All that remains then is to look up how much the furniture you've chosen costs, and start saving up. ☑



# Zygote

Amidst the tales of ministerial malevolence, corporate cock-ups and printable private parts, **Zygote** finally finds a heart-warming feelgood story from the tech world

## CARROT AND STICK

Carrot Neurotechnology has been fined \$150,000 for false advertising of its UltimEyes app for Android and iOS. The US Federal Trade Commission stated its “scientifically proven” promise for the \$10 app to boost athletic performance, improve eyesight and reverse the ageing process is a load of old cobblers. So Zygote must ask the obvious question: how much will the US Federal Trade Commission fine Microsoft for claiming that Windows 10 is “a more human way to do”?

## CRASH BARRIER

Zygote was delighted when Transport for London launched its latest website, fondly known as the Crash Map. It’s meant to improve road safety by showing nervous travellers exactly where every road death, serious injury, shunt and bump has happened.

Zygote was particularly interested in the data concerning Silicon Roundabout in Hackney, which is notorious for hapless techies getting knocked off their bikes by blinkered motorists. So it came as a bit of a surprise to find the Crash Map display a tally of zero such incidents over the past four years. Then, of course, the inevitable happened. A couple of hours after the Crash Map launched – and there is no kind way to put this – it crashed.

## WAVE GOODBYE

A Toulouse court has awarded a 39-year-old Frenchwoman £680 per month for suffering exposure to electromagnetic fields caused by mobile phones and Wi-Fi. Martine Richard claimed disability compensation because she said evil electronic waves were causing her headaches, sleep disruption and pains in her joints, so she had to move to a remote location.

Meanwhile, the World Health Organisation says sensitivity to electromagnetic waves is all in the mind. What Madame Richard seems to be suffering from is the belief that invisible rays are doing

her harm, which is a psychiatric condition, not a physical one. Zygote points out this is a selective psychosis, and sufferers ignore the fact that no matter how far from civilisation you go, electromagnetic waves are emitted by aircraft, satellites, the cosmos and our own dear sun. You can run, but you can’t hide.

## BOMBAY DUCK

Ravi Prasad, the Indian Minister of Communications and Information, has issued a statement about his new law to clamp down on data encryption. It includes the glorious phrase, “I have noted some of the concerns giving rise to uncalled-for misgivings”.

Uncalled for? He proposed a law forcing all citizens to store every encrypted message and item of data as plain text for 90 days, and then give the Indian government full access to it. Not content with that, his law would also require every foreigner who provides services to India from anywhere in the world to do exactly the same. Minister Prasad seems to have overlooked the fact that the whole purpose of encryption is to protect data from hackers, snoopers and, dare we say it, people like him.

## CLEVER DICK

Good news for anyone who has always felt the urge to print a

penis. The Biobot 3D printer has just gone on the market, and it’s a snip at only £6,500. Made in the US, it uses bio-ink mixed from a cocktail of cells and collagen, allowing some useful gristle to form part of the new appendage.

According to the marketing website, the Biobot is “a beautifully designed, precision manufactured robot that prints 3D living tissues out of human cells, bringing a new dimension to biology”. The manufacturers are already working on an upgrade to print computer-generated blood vessels and guts. Which will no doubt leave users cock-a-hoop. Speaking of which...

## PEPPED UP

The user contract for an emotionally endowed robot includes a clause that bans humans from having sex with it. Pepper is a social robot with innocent luminous eyes, flexible fingers, and a very trim waist. It is designed to “converse with you, react to your emotions, and live autonomously”, and it costs around £1,200. Produced by the romantic French in consortium with the futuristic Japanese, Clause 4 of Pepper’s contract forbids hosing it down “for the purpose of sexual or indecent behaviour, or for the purpose of associating with unacquainted persons of the opposite sex”.

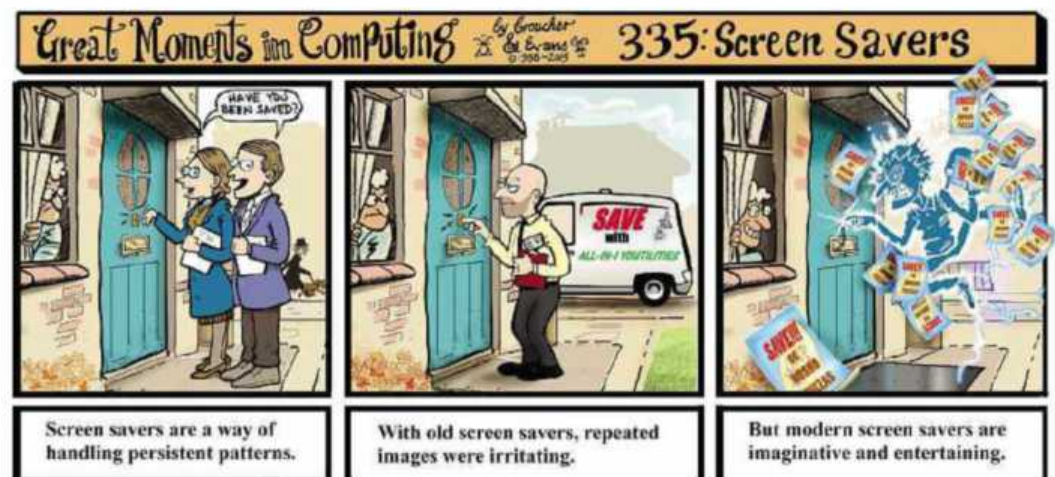
Zygote takes this to mean that pimping for gay sex with strangers is allowed within Pepper’s terms and conditions, but a robotic threesome is out, unless it’s with someone you’re already acquainted with. This restriction on Pepper is not to be sneezed at.

## WATCHMEN

Paul Houle, a teenager attending Tabor Academy in Cape Cod, wasn’t feeling so good after a football practice session, so he monitored his heart rate using an Apple Watch. The readings were alarming, and the school nurse took the lad off to hospital.

The Apple device was a lifesaver, because it turns out that if young Paul had played in the next day’s scheduled practice game, he may well have died. He suffers from a rare condition triggered by exercise, which causes his muscles to leak proteins and enzymes into his bloodstream, leading to failure of the heart, lungs and kidneys.

The story made the local press, and a few days later Paul was surprised to take a phone call from someone claiming to be Tim Cook, head of Apple, offering him a job at the company’s Cupertino headquarters. Zygote is happy to confirm that this story is absolutely true. All together now... aaw! ☑



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